SWCA
ENVIRONMENTAL CONSULTANTS

DRAFT

Memorandum

To: File

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From: Chris Garrett, SWCA

Date: August 25, 2013

Re: Revised Analysis of Surface Water Quality

A Preliminary Administrative FEIS was distributed to the cooperating agencies on July 1, 2013. Comments were received from both U.S. Environmental Protection Agency (USEPA) and the Arizona Department of Environmental Quality (ADEQ) regarding the analysis of surface water quality contained in the PAFEIS. The purpose of this memo is to outline a revised analysis in response to these comments, and to provide detailed analysis that will then be summarized in the FEIS.

Summary of Cooperating Agency Comments

The issues to be addressed are as follows:

- Part of the conclusions presented in the PAFEIS were based on the ability of two regulatory programs to protect surface water quality: the state water quality certification required under Section 401 of the Clean Water Act, and the Mining Multi-Sector General Permit (MSGP) issued by ADEQ to Rosemont under Section 402 of the Clean Water Act (which is administered in Arizona by ADEQ as the Arizona Pollutant Discharge Elimination System [AZPDES]). Both USEPA and ADEQ pointed out that the scope of the 401 water quality certification is actually quite narrowly defined, and likely would not require the ADEQ to make a wide-sweeping certification as to surface runoff water quality. Both agencies also pointed out that while the AZPDES permit has been issued, most details concerning surface water controls are contained in the Stormwater Pollution Prevention Plan (SWPPP), which had not been reviewed in the PAFEIS. ADEQ further pointed out that based on their review of the SWPPP, coverage under the MSGP could be nullified and Rosemont could be required to obtain an Individual AZPDES permit. For both 401 certification and 402 permitting these restrictions mean that it is not a sound strategy to rely upon the regulatory requirements to protect water quality, in lieu of analysis and disclosure of water quality impacts in the NEPA document.

- ADEQ questioned many aspects of the surface water quality analysis. Attempting to respond to these questions highlighted a lack of available detail concerning basic assumptions upon which water quality predictions were built, including the detection limits of the original laboratory samples, which types of analyses were used, and the number of samples available.

- In the PAFEIS, full disclosure of available data was included as well as full discussion of the many uncertainties associated with predicting runoff water quality. However, a detailed prediction of surface water quality was not attempted in the PAFEIS. ADEQ indicated that in their opinion some level of prediction needed to be attempted, even in light of significant uncertainty.

- In addition, some procedural errors in the surface water quality analysis were noted.

Strategy for Revised Surface Water Quality Analysis

The analysis of surface water quality that is included in the FEIS has been reworked in order to be responsive to USEPA and ADEQ comments. The analysis strategy consists of five parts:

1. In order to fully understand and disclose limitations of the data, it is necessary to go back to original data sources and construct a geochemical database for all existing water quality sources and all pertinent waste rock characterization tests, capturing important details such as detection limits. Previous analyses have relied upon Rosemont summaries of water quality, not original analysis of raw data, which is not sufficient.

2. Fully summarize existing water quality in order to understand existing conditions in downstream waters, specifically Barrel Canyon, Davidson Canyon, and Cienega Creek.

3. Based on a full understanding of the water quality and waste rock characterization data, disclose any uncertainties with the analysis and whether these uncertainties represent a potential to underestimate or overestimate surface water quality impacts from the mine.

4. Make a "good faith" effort to predict runoff water quality in Barrel Canyon. "Good faith" means that the uncertainties involved can be recognized but they should not preclude attempting the prediction, using reasonable assumptions. In Barrel Canyon, these predicted results should be compared to applicable surface water quality standards for Barrel Canyon and to existing water quality in Barrel Canyon.

5. Make a "good faith, screening level" effort to predict the potential for runoff water quality to impact the Outstanding Arizona Water (OAW) reaches of Davidson Canyon and Cienega Creek. The OAW analysis fundamentally differs from the estimate of impacts for Barrel Canyon. In Barrel Canyon, any impacts are immediately downstream, fairly certain to occur, and there are clear cut regulatory standards to meet. In contrast, the OAW reaches are a long distance downstream (about 12 miles), and more importantly there are no existing stormwater samples below Barrel Canyon that define existing stormwater quality.

   In addition to numeric standards, the OAW reaches also have an anti-degradation standard. A fundamental problem exists with any attempt at predicting impacts from the mine: without existing water quality it is an impossible task to predict whether degradation would occur. Further, in their comments ADEQ cautioned that the authority to make an anti-degradation conclusion lies with ADEQ, not the Forest Service. Therefore it is not the goal of this analysis to attempt a full prediction of post-construction stormwater quality that would occur at the OAW reaches. The goal instead is to perform a screening level analysis that would identify and disclose potential problem areas that could occur. Again, "good faith" means that the uncertainties involved should not preclude attempting the prediction.

6. Finally, there is one particular caution for any surface water quality analysis. Surface water quality standards for many dissolved metals vary with hardness. The assumption of hardness that goes into picking the appropriate surface water quality standard can be the difference between exceeding or not exceeding the standard. Two rules will guide all comparisons in the FEIS and in this memo.
   a. First, the standard will be calculated independently for each water being analyzed. In other words, Davidson Canyon, Cienega Creek, Barrel Canyon, SPLP results, MWMP results, and predicted mine runoff water quality will all have independent calculations made for hardness, in order to determine the appropriate standard to be applied. In three of these cases (Cienega Creek, Davidson Canyon, and Barrel Canyon) this is a moot point because the measured hardness is so high that it tops the scale in the Arizona regulations, which goes to 400 mg/L. The hardness used to calculate the standards will be clearly stated each time.
   b. Because hardness reporting varies widely, and for consistency sake, hardness will be calculated from calcium and magnesium concentrations, even if hardness has been reported by the laboratory. Note that the Arizona regulations define hardness as such: "Hardness" means the sum of the calcium and magnesium concentrations, expressed as calcium carbonate ($CaCO_3$) in milligrams per liter (R18-11-101).
   c. It should be noted that the Arizona regulations do not define whether the calcium and magnesium concentrations should be total (i.e., unfiltered) or dissolved (i.e., filtered). Based on professional judgment, the most common method is to use <u>total</u> calcium and magnesium concentrations to calculate hardness. In addition, using total concentrations best replicates the conditions that would be encountered in stormwater runoff.

Existing Waste Rock Characterization Data

<u>Geochemical Tests Available</u>

There are six basic types of geochemical characterization tests that have been conducted by Rosemont:
- Acid-base accounting (ABA) testing
- Whole rock chemistry
- Synthetic Precipitation Leaching Procedure (SPLP) testing
- Meteoric Water Mobility Procedure (MWMP) testing
- Humidity cell testing
- On-site column testing

The two of most interest for predicting stormwater runoff are the SPLP and MWMP tests.

SPLP – SPLP tests were originally designed to estimate the likely leaching of contaminants from landfills and waste. The method involves exposing waste rock to a slightly acidic liquid for a certain amount of time, and then analyzing the liquid for dissolved metals. The SPLP method involves the following components: 20:1 ratio of liquid to solid; approximate 18 hour run time; uses agitation; liquid pH = 4.2.

MWMP – MWMP tests were designed in Nevada specifically to estimate the likely movement of contaminants from freshly placed mine waste from rainwater. The method is similar in that it also involves exposing waste rock to liquid for a certain amount of time, and then analyzing the liquid for dissolved metals. The MWMP method involves the following components: 1:1 ratio of liquid to solid; 24-hour run time; no agitation; liquid is distilled water. The MWMP requires a larger amount of rock (5 kg) to run and therefore there are much fewer MWMP tests than SPLP tests. The number of individual laboratory samples available for assessment are summarized in Table 1:

Table 1. Summary of Number of Available Samples

Waste Rock Type	SPLP Samples	MWMP Samples
Abrigo	4	0
Andesite	4	4
Arkose	9	11
Bolsa	7	0
Colina	5	0
Composite	1	1
Earp	6	0
Epitaph	5	0
Escabrosa	4	0
Horquilla	8	2
Limestone/Limestone-Conglomerate	4	4
Martin	4	0
Overburden	2	2
Precambrian Formations	1	0
QMP	3	2

Both SPLP and MWMP are valid tests. In their mining BADCT guidance (for the Aquifer Protection program), ADEQ identifies SPLP as representative of meteoric contact water and being the preferred method for analyzing leaching potential. The dilution factor for SPLP also probably more accurately represents runoff from waste rock with typical Arizona rain events (i.e., for water to even reach Barrel Canyon, the event has to be fairly large and dilution would certainly occur). This memo will summarize waste rock characterization results for both SPLP and MWMP separately. SPLP results are used to predict future stormwater quality; a discussion of this choice is included in the "Recognized Analysis Uncertainties" section of this memo.

Summary of Waste Rock Characterization Data from SPLP Samples

Original waste rock characterization results were obtained from two published sources provided to the Forest Service by Rosemont (Tetra Tech 2007; Williamson and Levy 2008). A database was constructed from these reported results. Table 2 (attached) summarizes the range of leachate concentrations for all SPLP samples for each type of waste rock. The detection limits, or range of detection limits, is shown in Table 2 in parentheses below the range of leachate concentrations. Also included in Table 2 are the two Arizona surface water quality standards that are applicable to Barrel Canyon: Aquatic and wildlife-ephemeral-acute (A&We-Acute), and partial body contact (PBC) (see Arizona Administrative Code R18-11-105(1)). Hardness was calculated using the average calcium concentration of 34.14 mg/L and the average magnesium concentration of 1.62 mg/L, for a calculated hardness of 92 mg/L as $CaCO_3$. The color coding in Table 2 identifies where one or both of these standards have been exceeded:

Green indicates that the standards were not exceeded by any of the SPLP results, and that the detection limits were lower than the Barrel Canyon surface water quality standard. In other words—no problems exist.

Yellow indicates that there were no exceedances of the standards by any of the SPLP results, but that the detection limits were higher than the Barrel Canyon surface water quality standard. In other words—no problem is observed, but we can't know for sure.

Red indicates that there was at least one exceedance of the standards by the SPLP results. In other words, there is at least some indication that a problem meeting water quality standards currently exists.

Barrel Canyon - Potential Analysis Gaps and Water Quality Issues Identified from SPLP Samples

- Boron and Cyanide have standards but were not part of the analysis suite for SPLP results.
- Selenium was consistently not detected, but the laboratory detection limits were greater than the surface water standard (0.04 milligrams per liter [mg/L] versus 0.033 mg/L).
- Copper showed detections above the surface water standard for 3 waste rock types (arkose, bolsa, and QMP).

Significance of Copper Exceedances

- Arkose: standard exceeded in 1 of 9 samples. Remaining 8 samples were non-detect.

- Bolsa: standard exceeded in 2 of 7 samples. Remaining 5 samples were non-detect.
- QMP: standard exceeded in 1 of 3 samples. Remaining 2 samples had detectable copper, but below standard.

Summary of Waste Rock Characterization Data for MWMP Samples

Table 3 (attached) summarizes the range of leachate concentrations for all MWMP samples for each type of waste rock. The detection limits, or range of detection limits, is shown in parentheses in Table 3. Also included in Table 3 are the two Arizona surface water quality standards that are applicable to Barrel Canyon. Hardness was calculated using the average calcium concentration of 43.67 mg/L and the average magnesium concentration of 9.76 mg/L, for a calculated hardness of 149 mg/L as CaCO3. As with Table 2, the color coding identifies where one or both of these standards have been exceeded:

Green indicates that the standards were not exceeded by any of the MWMP results, and that the detection limits were lower than the standard. In other words—no problems exist.

Yellow indicates that there were no exceedances of the standards by any of the MWMP results, but that the detection limits were higher than the standard. In other words—no problem is observed, but we can't know for sure.

Red indicates that there was at least one exceedance of the standards by the MWMP results. In other words, there is at least some indication that a problem meeting water quality standards currently exists.

Barrel Canyon - Potential Analysis Gaps and Water Quality Issues Identified from MWMP Samples

- Boron, Cyanide, and Uranium have standards but were not part of the analysis suite for MWMP results.
- Selenium also had several waste rock types with non-detection, but the laboratory detection limits were greater than the surface water standard (0.04 mg/L versus 0.033 mg/L). Note that other waste rock types had detections of selenium.
- Copper showed detections above the surface water standard for 2 waste rock types (arkose and limestone).
- Selenium showed detections above the surface water standard for 3 waste rock types (andesite, arkose, and horquilla).

Significance of Copper Exceedances

- Arkose: standard exceeded in 1 of 11 samples. Remaining 10 samples were non-detect or below surface water standard.
- Limestone: standard exceeded in 1 of 4 samples. Remaining 3 samples were non-detect.

Significance of Selenium Exceedances

- Andesite: standard exceeded in 2 of 4 samples. Remaining 2 samples were non-detect, but with detection limit above surface water standard.
- Arkose: standard exceeded in 2 of 11 samples. Remaining 9 samples were non-detect, but with detection limit above surface water standard.
- Horquilla: standard exceeded in 1 of 2 samples. Remaining sample was non-detect, but with detection limit above surface water standard.

Existing Water Quality Data

A wide variety of sources were reviewed in order to obtain all available water quality data for Barrel Canyon, Davidson Canyon, and Cienega Creek. This includes the following:

- Rosemont Copper. Since 2008 Rosemont has collected stormwater quality samples in Barrel Canyon and tributaries. Samples have been collected from 8 different locations on 15 different dates.
- Rosemont Copper has also collected water quality samples from Upper and Lower Cienega Creek, and Lower Davidson Canyon on June 24, 2008 and October 21, 2008. Field conditions during these sampling events suggest that they represent baseflow conditions, not storm flow conditions.[1]
- The U.S. Geological Survey (USGS) National Water Information System (NWIS) database was searched for any available water quality data. No water quality samples were identified.

[1] In order to estimate whether samples represent baseflow or stormflow conditions, multiple data sources were checked. The results are summarized in Attachment A:

- Flow data for the USGS stream gage on Cienega Creek near Sonoita was reviewed to determine if any flow events were occurring or had occurred recently (http://waterdata.usgs.gov/nwis/dv/?referred_module=sw)
- Weather station data from the Rosemont site were reviewed (4/2009 – 9/2011)
- Flow measurements collected and recorded with the samples were reviewed
- Precipitation data from the Pima County Flood Control meteorological network were reviewed

- ADEQ and USEPA STORET databases were reviewed. These yielded 14 different sample locations on Cienega Creek, for 87 sample dates between 1987 and 2008. Field conditions during these sampling events suggest that they represent baseflow conditions, not storm flow conditions, with the exception of one sample collected at Marsh Station Road in 1988.[1]

- Pima Association of Governments (PAG) included samples for Davidson Canyon in their OAW nomination packet, for two locations at five dates in 2002 and 2003. Field conditions during these sampling events suggest that they represent baseflow conditions, not storm flow conditions.[1]

As can be seen, there is actually a fair amount of stormwater data available in Barrel Canyon upon which to base an analysis. However, based on the data sources reviewed, there are no available stormwater samples anywhere else in the watershed including Davidson Canyon and Cienega Creek.

A summary of existing stormwater quality results for Barrel Canyon is included in Table 4. The range of results shown is for all locations sampled within Barrel Canyon and tributaries and for all dates sampled. The detection limits, or range of detection limits, is shown in parentheses. Also included in Table 4 are the two Arizona surface water quality standards that are applicable to Barrel Canyon. Hardness was calculated using the average calcium concentration of 215 mg/L and the average magnesium concentration of 47.7 mg/L, for a calculated hardness of 733 mg/L as $CaCO_3$.

As with previous tables, the color coding identifies where one or both of these standards have been exceeded:

Green indicates that the standards were not exceeded by any of the existing stormwater results, and that the detection limits were lower than the standard. In other words—no problems exist.

Yellow indicates that there were no exceedances of the standards by any of the stormwater results, but that the detection limits were higher than the standard. In other words—no problem is observed, but we can't know for sure.

Red indicates that there was at least one exceedance of the standards by the stormwater results. In other words, there is at least some indication that a problem meeting water quality standards currently exists.

Barrel Canyon - Potential Analysis Gaps and Water Quality Issues Identified from Existing Stormwater Samples

- Cyanide and uranium have standards but were not part of the analysis suite for stormwater results.
- Total silver. Out of 21 samples, 2 exceeded the standard. The rest were below the standard or non-detect.
- Total arsenic. Out of 34 samples, 3 exceeded the standard. The rest were below the standard or non-detect (with one sample having a detection limit above the standard).
- Dissolved chromium. Out of 16 samples, all are non-detect. Three of those samples have detection limits above the surface water standard, but the remaining 13 are below the standard. Note that the surface water standards are for tri- or hexavalent chromium, whereas the stormwater analysis was for total chromium.
- Total copper. Out of 36 samples, 15 are above the surface water standard.
- Dissolved copper. Out of 31 samples, only one is above the surface water standard. Of the remaining samples, 3 are non-detect with detection limits above the surface water standard.
- Total lead. Out of 36 samples, 31 are above the surface water standard. Of the remaining samples, one has a detection limit above the surface water standard.
- Total selenium. Out of 20 samples, only one is above the surface water standard. The rest were below the standard or non-detect, although 6 have detection limits above the surface water standard.
- Total thallium. Out of 22 samples, only one is above the surface water standard. The rest were below the standard or non-detect, with 3 having detection limits above the surface water standard.

In summary: 1) total copper appears to be above the surface water standard consistently, and 2) total lead appears to be above the surface water standard consistently. Other constituents occasionally exceed water quality standards, but also often fall below water quality standards. For many constituents, detection limits higher than water quality standards reduce the number of useful samples.

Recognized Analysis Uncertainties

The goal of the surface water analysis is to make a "good faith" effort to predict water quality, recognizing the uncertainties involved but not allowing them to preclude analysis. There are four major uncertainties described in this section that must be considered.

Dissolved versus Total Concentrations and SPLP Results

Arizona surface water standards differentiate between total and dissolved concentrations, especially for metals. In the laboratory, the analytical method to determine metal concentrations is the same for both total and dissolved concentrations. The difference lies in the sample preparation. Total concentrations are derived from a water sample that has not been filtered, either in the field or in the lab. Dissolved concentrations, meanwhile, are derived from water samples that are filtered either in the field or in the lab (preferably in the field) using a 0.45-micron filter. This removes any solid or colloidal particles that would contribute to metal concentrations. For this reason, dissolved concentrations are usually considered the most representative for leachate percolating downwards to the aquifer or movement of contaminants through aquifers.

SPLP results are neither quite total nor dissolved. In the laboratory, after the sample is loaded with acidic solution and agitated for 18 hours, the resulting leachate is drained from the sample. This leachate is filtered using a 0.6 to 0.8-micron filter, and then analyzed. Because the sample is filtered at all, it is inconsistent with total metal concentrations. Because the filter size is slightly larger than 0.45-micron, the results are also inconsistent with dissolved metal concentrations. This represents an uncertainty in the analysis.

SPLP results are used in this analysis to estimate both total and dissolved concentrations. It is recognized that they may underestimate total concentrations, and may overestimate dissolved concentrations.

<u>Prediction of Type of Waste Rock Contacting Stormwater</u>

ADEQ issued an APP (Permit #106100) to Rosemont Copper on April 3, 2012. Under this permit, Rosemont is required to conduct operational waste rock characterization testing in order to properly segregate any waste rock that seems likely to contribute to acid rock drainage or cause other water quality issues. Note that the Forest Service is also requiring additional operational waste rock characterization testing above and beyond that required by ADEQ, which almost certainly would be used to guide similar waste rock segregation decisions.

The waste rock segregation plan approved by ADEQ (Krizek 2011) requires that:

- Non-acid generating waste rock will be preferentially placed in the east and south haul roads, screening berms, dry stack tailings buttresses and exterior haul roads, drain fills, permanent diversion crossings, the crusher haul road, as leach pad cover, and any other exterior surface. Acid generating waste rock will be placed to the interior of the Waste Rock Storage Area and possibly mixed (comingled) with nonacid generating waste rock. Additionally, potentially acid generating waste rock will not be placed immediately below within 50 feet of areas designated for water management ponds that are part of the final landform. Potentially acid generating material placed with the interior of the Waste Rock Storage Area will also not be placed in areas subject to water conveyance, etc.

- SPLP (EPA Method 1312) shall be completed at the on-site lab when constructed on samples used as outer berm/buttress or drain materials to confirm that these materials are non-acid generating and have limited reactivity.

In other words, the goal of operational testing is to make sure that problematic waste rock would not be used in areas where contact with stormwater would occur. This is desirable, but it adds uncertainty to trying to predict what waste rock types would contact stormwater. The percentages of each waste rock type in the overall waste rock facility are fully known; however, the percentages of each waste rock type that would be present in the drainage channels and perimeter buttresses where stormwater contact would occur are not known due to the requirements of the waste rock segregation plan. This represents an uncertainty in the analysis.

Predictions are made using the percentages of waste rock applicable to the entire waste rock facility. It is recognized that this would overestimate concentrations of metals in water quality runoff.

<u>Detection Limits</u>

The waste rock characterization, including the SPLP tests, were not conducted by Rosemont in order to support a surface water quality analysis. Rather, they were conducted to support the APP. This is pertinent, because while the detection limits used by the laboratory for the SPLP tests are below the Arizona aquifer water quality standards and therefore useful in assessing compliance under the APP program, in some cases the detection limits are greater than the Arizona surface water quality standards.

For a sample that has a detection limit greater than the regulatory standard, there is great uncertainty in the analysis. While it would be perfectly legitimate to say "selenium was not detected in the sample", in reality the actual concentration of selenium could be below the regulatory limit, equal to the regulatory limit, or greater than the regulatory limit.

This is a common problem when conducting water quality analyses. The most common practice when making calculations involving detection limits is to use one half of the detection limit for any sample that is non-detect. This is based on probability, reasoning that the actual concentration is as equally likely to be "zero" as it is to equal the detection limit. However, it must always be remembered that the result is a mathematical construct and there is no guarantee that the actual concentration would equal the result used in the calculation.

With respect to Rosemont, the detection limit problem is present with respect to selenium and silver. Selenium can be used as an example to illustrate the problem. The Arizona aquifer water quality standard for selenium is 0.05 mg/L. The detection limit for the SPLP tests was 0.04 mg/L, and in every case the SPLP result for selenium was below this detection limit. Therefore is would be valid to say that "selenium has never been detected in the SPLP samples." For the purposes of the APP, this statement means that Arizona aquifer water quality standards are unlikely to be exceeded.

However, the surface water quality standard in Barrel Canyon is 0.033 mg/L for selenium. Therefore even though it is still appropriate to say "selenium has never been detected in SPLP samples", none of the SPLP samples can be used to say with certainty that results were actually less than surface water quality standards.

When calculating the average concentration of selenium in order to predict runoff water quality, half the detection limit is used: 0.02 mg/L. While the conclusion reached is that the predicted water quality (0.02 mg/L) in stormwater runoff is less than the standard (0.033 mg/L), it is also true that every SPLP result could have been greater than the standard without us knowing it, although this is not the most probable scenario. This represents an uncertainty in the analysis.

The "good faith" analysis made in the FEIS uses half the detection limit as the most reasonable assumption. However, for full disclosure, a range of predictions is included in this memo, including using zero, half the detection limit, and the full detection limit in the calculations.

<u>SPLP versus MWMP Tests</u>

Both types of tests are intended to provide a reasonable analysis of what happens when water interacts with waste rock. The benefits and liabilities of each test are various. With respect to dilution, the SPLP test is probably more representative of conditions at Rosemont than the MWMP test. With respect to starting solution pH, the MWMP test is probably more representative of conditions at Rosemont than the SPLP test. With respect to sample size, the larger sample used in the MWMP test probably gives more of a representative sample than the SPLP test. With respect to agitation, arguments could be made that either the MWMP or SPLP tests are the most representative.

In the end, the choice to use SPLP tests is based as much on logistics as anything else. MWMP tests take such a large sample size, that there are very few of these samples conducted (26 MWMP versus 67 SPLP). Use of SPLP instead of MWMP tests represents an uncertainty in the analysis. Whether this would underpredict or overpredict metal concentrations in stormwater runoff is not clear.

It should also be noted that the use of SPLP results were questioned by the USEPA in their comments on the DEIS. The Forest contracted SRK to provide their opinion specifically on the use of SPLP results (Hoag, Sieber and Rasmussen 2012). SRK found that use of SPLP results in the models for the mine pit lake were reasonable and that use of other methods would have little effect on the model outcomes.

Prediction of Runoff Water Quality in Barrel Canyon

A prediction of the runoff water quality in Barrel Canyon can be made based on existing data. This includes waste rock characterization data to represent likely interaction of stormwater with the waste rock pile, and existing stormwater quality in Barrel Canyon.

The prediction is based on the following steps and assumptions:

- Water quality for runoff from the waste rock pile is based on SPLP results.
- SPLP results are assumed to be representative of both total and dissolved concentrations, depending on the water quality standard.
- Where SPLP results are below laboratory detection limits, half the detection limit is used in calculations. For disclosure, in this memo results are also shown using zero for non-detects, and using the full detection limit for non-detects.
- As a first step, all SPLP results for each given waste rock type are averaged.
- The averages for each waste rock type are then averaged again, but this average is weighted by the percentage each waste rock represents of the entire waste rock pile.
- The following are not incorporated into the analysis: any change in percentages due to waste rock segregation, any interaction of stormwater with soil or growth media instead of waste rock, any dilution effects in runoff from the waste rock facility, any dilution effects from contribution of other tributaries in Barrel Canyon.
- Predicted runoff water quality is first compared to the applicable surface water quality standards in Barrel Canyon. Hardness was calculated using the predicted calcium concentration of 16.42 mg/L and the average magnesium concentration of 1.06 mg/L, for a calculated hardness of 45.4 mg/L as $CaCO_3$.
- Any exceedances of surface water quality standards are then compared to existing water quality in Barrel Canyon to determine whether predicted conditions represent a difference from existing conditions.

Table 5 summarizes the predicted water quality runoff, for the three different methods of handling detection limits, compared to surface water quality standards in Barrel Canyon. Under the most reasonable scenario to be used in the FEIS (non-detects equal half the detection limit), predicted water quality runoff only exceeds the standard for dissolved silver (0.0025 mg/L predicted versus 0.00081 mg/L standard). All other analytes are below the surface water quality standards.

As shown previously in Table 4, the surface water quality standard for dissolved silver has been exceeded previously in existing stormwater samples from Barrel Canyon. This can be looked at in more detail:

- Of 18 existing stormwater samples analyzed for dissolved silver, two samples are above detection limits and exceed the predicted runoff water quality for dissolved silver.
- Of the remaining 16 existing stormwater samples, three are non-detect, with the detection limit less than the predicted runoff water quality.
- Of the remaining 13 existing stormwater samples, detection limits are greater than the predicted runoff water quality. These samples are of no utility for comparing predicted to existing results.
- In summary, there are five existing stormwater samples to consider. Of these, two indicate that existing stormwater quality exceeds predicted runoff water quality, and three indicate that existing stormwater quality is less than predicted runoff water quality.

<u>Conclusion of Impacts to Runoff Water Quality in Barrel Canyon</u>

The "good faith" prediction of runoff water quality impacts in Barrel Canyon indicates that there are unlikely to be exceedances of surface water quality standards that don't already occur. Dissolved silver is predicted to exceed surface water standards in runoff; however, in 40% of the useful samples in Barrel Canyon, dissolved silver already exceeded these standards under pre-mine conditions.

Clearly, it could also be argued that 60% of the time dissolved silver does not exceed standards in Barrel Canyon, and therefore the opposite conclusion would be equally valid—that more often than not predicted runoff water quality would exceed surface water quality standards and be worse than existing conditions. The probabilities are roughly the same, but the conclusions are opposite.

In this case, some consideration has to be given to three uncertainties of the analysis. Specifically, the waste rock segregation plan, the use of growth media, and water hardness. The waste rock segregation plan is designed to test for and limit stormwater exposure to problematic waste rock, which is a highly beneficial activity although it makes prediction difficult. Further, growth media derived from the natural soils around the site would be placed over much of the waste rock (excluding some steep slopes and the conveyance channels). This would largely prevent stormwater contact with waste rock, although exposure would certainly occur in some places and in particular in the conveyance channels. The safety factors introduced by both of these cases lend themselves to conclude that there are unlikely to be surface water quality impacts in Barrel Canyon.

In addition, it should be noted that the hardness used to derive the surface water standards (45 mg/L as $CaCO_3$) is significantly lower than the hardness actually encountered in existing stormwater in Barrel Canyon (733 mg/L as $CaCO_3$). A change in hardness would result in a much higher surface water quality standard for dissolved silver (0.04962 mg/L at a hardness of >400 mg/L $CaCO_3$ versus 0.00081 mg/L at a hardness of 45 mg/L $CaCO_3$). If hardness were as high as observed in existing stormwater samples, predicted water quality would not exceed the surface water quality standard for dissolved silver. In fact, a hardness of 87 mg/L as $CaCO_3$ would result in a surface water standard higher than the predicted water quality. Of 37 stormwater samples collected in Barrel Canyon and its tributaries, 34 of those samples have hardness greater than 87 mg/L as $CaCO_3$.

Screening Level Analysis of Degradation of Water Quality at OAWs

As noted, it is impossible to attempt a comparison of effects on surface water quality runoff in the downstream OAW segments of Davidson Canyon and Cienega Creek, for the very simple fact that no stormwater samples appear to exist anywhere else in the watershed except in Barrel Canyon.

However, a "screening level" analysis can be made to estimate the effect the predicted runoff might have on existing water quality. The limitations of this analysis are significant. Therefore this analysis will not be used to predict whether or not degradation will occur downstream, and will not be used to determine whether surface water quality standards in the OAW segments will be exceeded. This is simply beyond the ability to predict. What can be done is to identify whether any constituents raise red flags that should be watched and considered in the context of permitting under section 401 and 402 of the Clean Water Act.

Given the limited data available, the screening analysis is relatively straight forward:

- The surface disturbance from the mine represents approximately 4,500 acres of the Davidson Canyon watershed.
- The entire drainage basin of the Davidson Canyon watershed is approximately 32,300 acres (obtained from USGS summary of gage 09484590, which was located approximately where the OAW segment begins).
- The predicted runoff water quality therefore represents approximately 14% of the flow in the watershed. Comments from cooperating agencies, particularly Pima County, have pointed out that the Barrel Canyon drainage may contribute more runoff than a strict acreage percentage would suggest, due to its location higher in the watershed. This is acknowledged. On the other hand, it should be acknowledged that runoff from local sources (in

contrast to Barrel Canyon, which lies approximately 12 miles upstream) is more likely to affect the OAW segments on a frequent basis than distant flow from Barrel Canyon. These are uncertainties in the analysis, and at the level of screening being attempted, do not weigh into the final analysis.

- Since the only stormwater samples existing in the entire Davidson Canyon drainage appear to be those collected by Rosemont in Barrel Canyon, these samples will have to stand in for the 85% of the drainage basin not affected by the mine site.
- The screening level analysis consists of four parts:
    - First, calculate an average of existing stormwater quality results, using all available stormwater quality samples and handling any non-detect values using half of the detection limit.
    - Second, calculate a weighted average using the existing stormwater quality results (85%) and the predicted water quality runoff results from either the waste rock facility or the soil cover (15%). (In the FEIS Surface Water Quality section, several scenarios are analyzed for impacts to water quality in Barrel Canyon, including runoff from the waste rock with no segregation, runoff from soil cover, and possible daylighting of tailings in Barrel Canyon.)
    - Third, compare the predicted runoff water quality without the mine (i.e., step 1 above) to the predicted runoff water quality with the mine (i.e., step 2 above).
    - Fourth, identify those constituents that are <u>significantly</u> higher under the mining scenario. Significance is based on professional opinion and is set at 10%. This is primarily due to the uncertainties present in this screening analysis.

Results of the screening analysis are shown in Table 6. Based on the screening analysis, concentrations of most analytes actually have the potential to decrease under the mining scenario.

<u>Under the waste rock runoff scenario, only two analytes suggest that care should be taken with respect to downstream waters. Molybdenum (both dissolved and total) is approximately 20% higher under the post-mine scenario, and sulfate (both dissolved and total) is almost 50-100% higher.</u>

<u>Under the soil cover runoff scenario, molybdenum and sulfate are acceptable but dissolved arsenic, iron, and sodium are elevated (up to about 20% higher), and both total and dissolved mercury are significantly elevated (200 to 1,000% higher). The high mercury is driven by one extremely high SPLP soil sample.</u>

The actual runoff would likely be a mix of these two scenarios, and also would be mitigated by testing and waste rock segregation activities. Given that existing stormwater quality appears to have never been sampled in Davidson Canyon, this analysis simply cannot be taken any further than to raise and acknowledge these concerns.

References

Hoag, C., Sieber, M., and Rasmussen, J. 2012. Memorandum: Rosemont Copper DEIS – Response to EPA Geochemistry Comments – Final. July 18.

Krizek, D. 2011. Technical Memorandum: Rosemont Waste Rock Segregation Plan – Revision 1. January 25, 2011.

Tetra Tech. 2007. Geochemical Characterization, Addendum 1, Rosemont Copper. November 2007.

Williamson, M., and Levy, D. 2008. Technical Memorandum: Geochemistry Sample Update. November 10, 2008.

Table 2. Summary of SPLP Results for Waste Rock Samples

Analyte	Range of SPLP Results by Waste Rock Type with Range of Detection Limits in Parentheses (mg/L)															Surface Water Standards for Ephemeral Tributaries	
	Abrigo	Andesite	Arkose	Bolsa	Colina	Composite	Earp	Epitaph	Escabrosa	Horquilla	Limestone/ Limestone-Conglomerate	Martin	Overburden	Precambrian Formations	QMP	A&We-Acute	PBC
Ag	ND (0.005)	ND (0.005)	ND (0.005)	ND (0.005)	ND (0.005)	ND (0.005)	ND (0.005)	ND (0.005)	ND (0.005)	ND (0.005)	ND (0.005)	ND (0.005)	ND (0.005)	ND (0.005)	ND (0.005)	0.01242 (D)	4.667 (T)
As	ND-0.005 (0.02)	ND-0.024 (0.025)	ND-0.06 (0.025)	ND-0.005 (0.02)	ND (0.003-0.02)	ND (0.025)	ND-0.004 (0.003-0.02)	ND-0.004 (0.02)	ND (0.02)	ND-0.005 (0.02-0.025)	ND-0.008 (0.003)	ND (0.02)	0.013-0.048	ND (0.003)	ND-0.013 (0.003)	0.44 (D)	0.28 (T)
B																	186.667 (T)
Ba	ND-0.0053 (0.002)	ND-0.0049 (0.002)	ND-0.0305 (0.002)	ND-0.01 (0.002)	0.007-0.0393	0.0037	ND-0.0125 (0.002)	ND-0.03 (0.002)	ND-0.003 (0.002)	ND-0.11 (0.002)	ND-0.0182 (0.002)	ND-0.004 (0.002)	0.0544-0.0717	0.0466	ND-0.0334 (0.002)		98 (T)
Be	ND (0.002)	ND (0.002)	ND (0.002)	ND (0.002)	ND (0.002)		ND (0.002)	ND (0.002)	ND (0.002)	ND (0.002)	ND (0.002)	ND (0.002)	ND (0.002)	ND (0.002)	ND (0.002)		1.867 (T)
Cd	ND (0.002)	ND (0.002)	ND (0.002)	ND-0.006 (0.002)	ND (0.002)	ND (0.002)	ND (0.002)	ND (0.002)	ND (0.002)	ND (0.002)	ND (0.002)	ND (0.002)	ND (0.002)	ND (0.002)	ND (0.002)	0.02103 (D)	0.7 (T)
Cr	ND (0.006)	ND (0.006)	ND (0.006)	ND (0.006)	ND (0.006)	ND (0.006)	ND (0.006)	ND (0.006)	ND (0.006)	ND (0.006)	ND (0.006)	ND (0.006)	ND (0.006)	ND (0.006)	ND (0.006)	CrIII (1.785) (D) CrVI (0.034) (D)	CrIII (1400) (T) CrVI (2.8) (T)
Cn																0.084 (T)	18.667 (T)
Cu	ND (0.01)	ND (0.01)	ND-0.032 (0.01)	ND-0.3 (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND-0.021 (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	0.011-0.05	0.0215 (D)	1.3 (T)
F	0.1-0.4	0.22-0.4	0.12-0.55	ND-0.59 (0.1)	0.3-2.42	0.22	0.15-0.76	0.45-2.49	0.23-0.82	0.29-1.21	ND-0.27 (0.1)	0.14-0.47	0.31-0.33	ND (1)	0.2-0.4		140 (T)
Hg	ND-0.0006 (0.0002)	ND (0.0002)	ND-0.0019 (0.0002)	ND-0.0002 (0.0002)	ND (0.0002)	ND (0.0002)	ND (0.0002)	ND (0.0002)	ND (0.0002)	ND (0.0002)	ND (0.0002)	ND (0.0002)	ND (0.0002)	ND (0.0002)	ND (0.0002)	0.005 (D)	0.28 (T)
Mn	ND (0.004)	ND-0.0112 (0.004)	ND-0.0177 (0.004)	ND-0.61 (0.004)	ND-0.009 (0.004)	0.0066	ND (0.004)	ND (0.004)	ND (0.004)	ND-0.03 (0.004)	ND-0.0064 (0.004)	ND (0.004)	ND-0.0108 (0.004)	0.0067	ND-0.0056 (0.004)		130.667 (T)
Ni	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)		ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	3.875 (D)	28 (T)
NO2+NO3 as N		ND-0.075 (0.02)	0.02-0.03		0.082	0.03	ND			0.04							NO2 (233.333) (T) NO3 (3733.333) (T)
Pb	ND (0.0075)	ND (0.0075)	ND-0.0203 (0.0075)	ND (0.0075)	ND (0.0075)	ND (0.0075)	ND (0.0075)	ND (0.0075)	ND (0.0075)	ND (0.0075)	ND (0.0075)	ND (0.0075)	ND-0.031 (0.0075)	ND (0.0075)	ND (0.0075)	0.12445 (D)	0.015 (T)
Sb	ND (0.02)	ND (0.02)	ND (0.02)	ND (0.02)	ND (0.02)	ND (0.02)	ND (0.02)	ND (0.02)	ND (0.02)	ND (0.02)	ND (0.02)	ND (0.02)	ND (0.02)	ND (0.02)	ND (0.02)		0.747 (T)
Se	ND (0.04)	ND (0.04)	ND (0.04)	ND (0.04)	ND (0.04)	ND (0.04)	ND (0.04)	ND (0.04)	ND (0.04)	ND (0.04)	ND (0.04)	ND (0.04)	ND (0.04)	ND (0.04)	ND (0.04)	0.033 (T)	4.667 (T)
Tl	ND (0.015-0.02)	ND (0.015)	ND (0.015)	ND (0.015-0.02)	ND (0.02)		ND (0.015-0.02)	ND (0.015-0.02)	ND (0.02)	ND (0.015-0.02)	ND (0.015)	ND (0.02)	ND (0.015)	ND (0.015)	ND (0.015)		0.075 (T)
U	ND (0.004-0.005)			ND (0.002-0.005)	ND (0.004)		ND (0.004)	ND (0.004-0.005)	ND (0.004)	ND (0.005)		ND (0.004)					2.8 (T)
Zn	ND (0.01)	ND (0.01)	ND-0.012 (0.01)	ND-0.12 (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND-0.015 (0.01)	ND (0.01)	ND (0.01)	1.036 (D)	280 (T)

(D) - Dissolved
(T) - Total
ND - Non detect, with range of detection limits shown in parentheses
A&We-Acute - Surface water standard for aquatic and wildlife - ephemeral, for acute exposure, based on hardness of 92 mg/L as CaCO3
PBC - Partial Body Contact

Yellow highlighted cells indicate that the analyte was not detected, but that the detection limits were greater than the surface water standard

Red highlighted cells indicate that the analyte was detected at least once above the surface water standard

Green highlighted cells indicate that the analyte was not detected, and that detection limits were less than the surface water standard

Table 3. Summary of MWMP Results for Waste Rock Samples

Analyte	Range of MWMP Results by Waste Rock Type with Range of Detection Limits in Parentheses (mg/L)							Surface Water Standards for Ephemeral Tributaries	
	Andesite	Arkose	Composite	Horquilla	Limestone/ Limestone-Conglomerate	Overburden	QMP	A&We-Acute	PBC
Ag	ND (0.005)	ND (0.005)	ND (0.005)	ND (0.005)	ND (0.005)	ND (0.005)	ND (0.005)	0.01957 (D)	4.667 (T)
As	ND-0.031 (0.025)	ND-0.039 (0.003)	ND (0.025)	ND-0.027 (0.025)	ND-0.005 (0.003)	0.064-0.071	ND (0.003)	0.44 (D)	0.28 (T)
B									186.667 (T)
Ba	0.0061-0.0426	0.0028-0.0194	0.027	0.0047-0.0151	ND-0.063 (0.002)	0.0082-0.0324	0.0034-0.0053		98 (T)
Be	ND (0.002)	ND (0.002)		ND (0.002)	ND (0.002)	ND (0.002)	ND (0.002)		1.867 (T)
Cd	ND (0.002)	ND (0.002)	ND (0.002)	ND (0.002)	ND (0.002)	ND (0.002)	ND (0.002)	0.0336 (D)	0.7 (T)
Cr	ND (0.006)	ND (0.006)	ND (0.006)	ND (0.006)	ND (0.006-0.06)	ND (0.006)	ND (0.006)	CrIII (2.65) (D) CrVI (0.034) (D)	CrIII (1400) (T) CrVI (2.8) (T)
Cn								0.084 (T)	18.667 (T)
Cu	ND (0.01)	ND-0.037 (0.01)	ND (0.01)	ND (0.01)	ND-0.036 (0.01)	0.012-0.016	ND (0.01)	0.03387 (D)	1.3 (T)
F	0.48-1.76	0.31-2.09	1.51	1.3-1.62	0.17-0.65	1.22-1.39	0.26-0.36		140 (T)
Hg	ND-0.0002 (0.0002)	ND (0.0002)	ND (0.0002)	ND (0.0002)	ND (0.0002)	ND (0.0002)	ND (0.0002)	0.005 (D)	0.28 (T)
Mn	ND-0.033 (0.004)	ND-0.012 (0.004)	0.02	ND (0.004)	ND-0.009 (0.004)	ND (0.004)	ND-0.006 (0.004)		130.667 (T)
Ni	ND (0.01)	ND (0.01)		ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	5.827 (D)	28 (T)
NO2+NO3 as N	0.07	0.013-0.04	ND (0.02)	0.03	0.201-1.43		0.284		NO2 (233.333) (T) NO3 (3733.333) (T)
Pb	ND-0.0874 (0.0075)	ND (0.0075)	ND (0.0075)	ND (0.0075)	ND-0.112 (0.0075)	ND (0.0075)	ND (0.0075)	0.2098 (D)	0.015 (T)
Sb	ND (0.02)	ND (0.02)	ND (0.02)	ND (0.02)	ND (0.02)	ND (0.02)	ND (0.02)		0.747 (T)
Se	ND-0.1 (0.04)	ND-0.32 (0.04)	0.05	ND-0.18 (0.04)	ND (0.04)	ND (0.04)	ND (0.04)	0.033 (T)	4.667 (T)
Tl	ND (0.015)	ND (0.015)		ND (0.015)	ND (0.015)	ND (0.015)	ND (0.015)		0.075 (T)
U									2.8 (T)
Zn	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	1.559 (D)	280 (T)

(D) - Dissolved
(T) - Total
ND - Non detect, with range of detection limits shown in parentheses
A&We-Acute - Surface water standard for aquatic and wildlife - ephemeral, for acute exposure, based on hardness of 149 mg/L as CaCO3
PBC - Partial Body Contact

Yellow highlighted cells indicate that the analyte was not detected, but that the detection limits were greater than the surface water standard

Red highlighted cells indicate that the analyte was detected at least once above the surface water standard

Green highlighted cells indicate that the analyte was not detected, and that detection limits were less than the surface water standard

Table 4. Summary of Barrel Canyon Existing Stormwater Quality Results

Analyte	Total/Dissolved	Range of Concentrations in Barrel Canyon Stormwater Samples (in mg/L), with Range of Detection Limits shown in Parentheses	A&We-Acute	PBC
Ag	Dissolved	ND-0.0341 (0.001-0.05)	0.04962	
Ag	Total	ND-43.8 (0.005-0.1)		4.667
As	Dissolved	ND-0.029 (0.01-0.1)	0.44	
As	Total	ND-0.459 (0.01-0.3)		0.28
B	Total	ND-0.578 (0.05-1)		186.667
Ba	Total	ND-7.49 (0.1-1)		98
Be	Total	ND-0.0552 (0.002-0.05)		1.867
Cd	Dissolved	ND (0.002-0.05)	0.08761	
Cd	Total	ND-0.053 (0.003-0.3)		0.7
Cr	Dissolved	ND (0.005-0.1)	CrIII(5.95) CrVI(0.034)	
Cr	Total	ND-1.2 (0.01-0.5)		CrIII(1400) CrVI(2.8)
Cn	Total		0.084	18.667
Cu	Dissolved	ND-0.152 (0.01-0.1)	0.08588	
Cu	Total	ND-29 (0.01-0.1)		1.3
F	Total	ND-0.17 (0.05-0.5)		140
Hg	Dissolved	ND (0-0.002)	0.005	
Hg	Total	ND-0.00176 (0.0001-0.01)		0.28
Mn	Total	ND-39.3 (0.02-0.1)		130.667
Ni	Dissolved	ND-4.84 (0.005-0.1)	13.436	
Ni	Total	ND-19 (0.01-0.5)		28
NO3+NO2 as N	Total	ND-8.3 (0.1-1)		NO2 (233.333) NO3 (3733.333)
Pb	Dissolved	ND-0.0748 (0.002-0.15)	0.59271	
Pb	Total	ND-6.5 (0.01-0.1)		0.015
Sb	Total	ND (0.002-0.25)		0.747
Se	Total	ND-19.1 (0.002-0.25)	0.033	4.667
Tl	Total	ND-0.181 (0.0005-0.5)		0.075
U	Total			2.8
Zn	Dissolved	ND (0.03-0.5)	3.599	
Zn	Total	ND-17 (0.003-0.5)		280

* Range includes samples from 8 different locations in Barrel Canyon, for 15 different dates
ND - Non detect, with range of detection limits shown in parentheses
A&We-Acute - Surface water standard for aquatic and wildlife - ephemeral, for acute exposure, based on hardness of 400 mg/L as $CaCO_3$
PBC - Partial Body Contact

Yellow highlighted cells indicate that the analyte was not detected, but that the detection limits were greater than the surface water standard

Red highlighted cells indicate that the analyte was detected at least once above the surface water standard

Green highlighted cells indicate that the analyte was not detected, and that detection limits were less than the surface water standard

Table 5. Summary of Predicted Runoff Water Quality

Analyte	Predicted Runoff Water Quality (mg/L)			Surface Water Standards for Ephemeral Tributaries	
	Non-Detects = Zero	Non-Detects = Half of Detection Limit	Non-Detects = Detection Limit	A&We-Acute	PBC
Ag	0.000000	0.002500	0.005000	0.00081 (D)	4.667 (T)
Al	0.206457	0.204967	0.209680		
As	0.007033	0.012950	0.019225	0.44 (D)	0.28 (T)
Au	0.000000	0.002500	0.005000		
B					186.667 (T)
Ba	0.006731	0.007056	0.007380		98 (T)
Be	0.000000	0.001000	0.002000		1.867 (T)
Ca	16.423100	16.423100	16.423100		
Cd	0.000857	0.001017	0.002013	0.01049 (D)	0.7 (T)
Cr	0.000000	0.003000	0.006000	CrIII (0.994) (D) CrVI (0.034) (D)	CrIII (1400) (T) CrVI (2.8) (T)
Cn				0.084 (T)	18.667 (T)
Cl	0.960117	0.963446	0.966775		
Cu	0.006266	0.008487	0.012993	0.01096 (D)	1.3 (T)
F	0.330751	0.331622	0.333870		140 (T)
Fe	0.216062	0.163811	0.178491		
Hg	0.000196	0.000231	0.000322	0.005 (D)	0.28 (T)
K	2.925838	2.933669	2.941499		
Mg	1.064085	1.064085	1.064085		
Mn	0.006818	0.006936	0.008412		130.667 (T)
Mo	0.041151	0.040522	0.040938		
Na	4.167096	4.167096	4.167096		
Ni	0.000000	0.005000	0.010000	2.116 (D)	28 (T)
NO2+NO3a	0.030767	0.031011	0.031255		NO2 (233.333) (T) NO3 (3733.333) (T)
Pb	0.002264	0.004831	0.008336	0.05657 (D)	0.015 (T)
Sb	0.000000	0.010000	0.020000		0.747 (T)
Se	0.000000	0.020000	0.040000	0.033 (T)	4.667 (T)
SO4	33.125586	33.125586	33.125586		
TDS	78.407441	78.407441	78.407441		
Tl	0.000000	0.008160	0.016320		0.075 (T)
U	0.000000	0.002235	0.004470		2.8 (T)
Zn	0.001941	0.005838	0.010496	0.565 (D)	280 (T)

(D) - Dissolved
(T) - Total
ND - Non detect, with range of detection limits shown in parentheses
A&We-Acute - Surface water standard for aquatic and wildlife - ephemeral, for acute exposure, based on hardness of 45 mg/L as CaCO3

PBC - Partial Body Contact

Yellow highlighted cells indicate that the predicted runoff water quality exceeds one of the applicable surface water quality standards

Green highlighted cells indicate that the predicted runoff water quality is less than the applicable surface water quality standards

Table 6. Screening Level Analysis of Potential Impacts to Watershed

Analyte	Total/ Dissolved	Average of Existing Water Quality in Barrel Canyon (mg/L)	Number of Existing Stormwater Samples	Predicted Runoff Water Quality from Waste Rock (mg/L)	Predicted Runoff Water Quality from Soil Cover (mg/L)	Pre-Mine Prediction of Watershed Water Quality (mg/L)	Post-Mine Prediction of Watershed Water Quality Using Waste Rock Runoff (mg/L)*	Percent Change due to Mining based on Waste Rock Runoff**	Post-Mine Prediction of Watershed Water Quality Using Soil Cover (mg/L)*	Percent Change due to Mining based on Soil Cover Runoff**
Ag	Dissolved	0.009011	18	0.0025	0.0025	0.009011	0.008034	-11%	0.008034	-11%
Ag	Total	2.713919	21	0.0025	0.0025	2.713919	2.307206	-15%	2.307206	-15%
Al	Dissolved	0.424810	21	0.204966578	0.487	0.424810	0.391833	-8%	0.434138	2%
Al	Total	87.141553	38	0.204966578	0.487	87.141553	74.101065	-15%	74.143370	-15%
As	Dissolved	0.016144	18	0.012950298	0.0335	0.016144	0.015665	-3%	0.018748	16%
As	Total	0.112347	34	0.012950298	0.0335	0.112347	0.097438	-13%	0.100520	-11%
Ba	Dissolved	0.078251	35	0.007055648	0.0047	0.078251	0.067572	-14%	0.067219	-14%
Ba	Total	1.162255	38	0.007055648	0.0047	1.162255	0.988975	-15%	0.988622	-15%
Be	Dissolved	0.008350	15	0.001	0.001	0.008350	0.007248	-13%	0.007248	-13%
Be	Total	0.012303	31	0.001	0.001	0.012303	0.010607	-14%	0.010607	-14%
Ca	Dissolved	25.239130	23	16.42309985	6.6	25.239130	23.916726	-5%	22.443261	-11%
Ca	Total	214.900000	37	16.42309985	6.6	214.900000	185.128465	-14%	183.655000	-15%
Cd	Dissolved	0.005800	15	0.001016591	0.001	0.005800	0.005082	-12%	0.005080	-12%
Cd	Total	0.023836	29	0.001016591	0.001	0.023836	0.020413	-14%	0.020410	-14%
Cl	Dissolved	2.803846	13	0.963446019	0.5357	2.803846	2.527786	-10%	2.463624	-12%
Cl	Total	5.678846	26	0.963446019	0.5357	5.678846	4.971536	-12%	4.907374	-14%
Cr	Dissolved	0.013625	16	0.003	0.003	0.013625	0.012031	-12%	0.012031	-12%
Cr	Total	0.110510	30	0.003	0.003	0.110510	0.094384	-15%	0.094384	-15%
Cu	Dissolved	0.033094	31	0.008486731	0.0067	0.033094	0.029403	-11%	0.029135	-12%
Cu	Total	2.947389	36	0.008486731	0.0067	2.947389	2.506554	-15%	2.506286	-15%
F	Dissolved	0.250000	5	0.331622173	0.2063	0.250000	0.262243	5%	0.243445	-3%
F	Total	0.216333	15	0.331622173	0.2063	0.216333	0.233627	8%	0.214828	-1%
Fe	Dissolved	0.141800	20	0.163810814	0.2433	0.141800	0.145102	2%	0.157025	11%
Fe	Total	102.701921	38	0.163810814	0.2433	102.701921	87.321205	-15%	87.333128	-15%
Hg	Dissolved	0.000142	13	0.000231276	0.0101	0.000142	0.000156	9%	0.001636	1050%
Hg	Total	0.000703	20	0.000231276	0.0101	0.000703	0.000632	-10%	0.002112	201%
K	Dissolved	4.794524	21	2.933668516	1.503	4.794524	4.515396	-6%	4.300795	-10%
K	Total	28.463235	34	2.933668516	1.503	28.463235	24.633800	-13%	24.419200	-14%
Mg	Dissolved	1.989853	34	1.064085474	0.8167	1.989853	1.850988	-7%	1.813880	-9%
Mg	Total	47.885556	36	1.064085474	0.8167	47.885556	40.862335	-15%	40.825227	-15%
Mn	Dissolved	0.340557	23	0.006936164	0.161	0.340557	0.290513	-15%	0.313623	-8%
Mn	Total	6.130769	39	0.006936164	0.161	6.130769	5.212194	-15%	5.235304	-15%
Mo	Dissolved	0.017181	21	0.040521716	0.0117	0.017181	0.020682	20%	0.016359	-5%
Mo	Total	0.017835	19	0.040521716	0.0117	0.017835	0.021238	19%	0.016915	-5%
Na	Dissolved	2.517750	20	4.167095722	6.1	2.517750	2.765152	10%	3.055088	21%
Na	Total	7.007750	28	4.167095722	6.1	7.007750	6.581652	-6%	6.871588	-2%
Ni	Dissolved	0.296618	17	0.005	0.005	0.296618	0.252875	-15%	0.252875	-15%
Ni	Total	0.678258	33	0.005	0.005	0.678258	0.577269	-15%	0.577269	-15%
NO3+NO2	Total	1.704387	31	0.031010942	Not sampled	1.704387	1.453381	-15%	Not sampled	-
Pb	Dissolved	0.023476	17	0.004830868	0.0151	0.023476	0.020680	-12%	0.022220	-5%
Pb	Total	0.883694	36	0.004830868	0.0151	0.883694	0.751865	-15%	0.753405	-15%
Sb	Dissolved	0.023971	17	0.01	0.0052	0.023971	0.021875	-9%	0.021155	-12%
Sb	Total	0.043632	19	0.01	0.0052	0.043632	0.038587	-12%	0.037867	-13%
Se	Dissolved	0.014031	16	0.02	0.02	0.014031	0.014927	6%	0.014927	6%
Se	Total	0.986361	20	0.02	0.02	0.986361	0.841407	-15%	0.841407	-15%
SO4	Dissolved	4.475000	14	33.12558562	1.98	4.475000	8.772588	96%	4.100750	-8%
SO4	Total	7.792963	27	33.12558562	1.98	7.792963	11.592856	49%	6.921019	-11%
TDS	Dissolved	194.678571	28	78.40744094	Not sampled	194.678571	177.237902	-9%	Not sampled	-
Tl	Dissolved	0.013619	18	0.008160238	0.0028	0.013619	0.012801	-6%	0.011997	-12%
Tl	Total	0.032841	22	0.008160238	0.0028	0.032841	0.029139	-11%	0.028335	-14%
Zn	Dissolved	0.069667	15	0.005838461	0.0066	0.069667	0.060092	-14%	0.060207	-14%
Zn	Total	2.202408	38	0.005838461	0.0066	2.202408	1.872922	-15%	1.873037	-15%

* Weighted average based on 85% existing water quality, 15% predicted runoff water quality

** Negative change indicates that water quality would improve under mining scenario. Positive change indicates that water quality would degrade.

Green highlighting indicates that water quality is predicted to improve under mining scenario

Yellow highlighting indicates that water quality is predicted to degrade under mining scenario, but not by a significant amount

Red highlighting indicates that water quality is predicted to degrade significantly under mining scenario

ATTACHMENT A

SUMMARY OF ALL AVAILABLE SURFACE WATER SAMPLES

Sample Location	General Location	Date
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	5/29/1987
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	8/21/1987
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	10/15/1987
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	11/24/1987
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	1/18/1988
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	4/5/1988
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	5/4/1988
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	7/20/1988
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	9/21/1988
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	11/22/1988
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	1/25/1989
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	3/30/1989
CIENEGA CREEK - AT TILTED BEDS	CC Above Davidson	3/30/1989
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	5/23/1989
CIENEGA CREEK - AT TILTED BEDS	CC Above Davidson	5/23/1989
CIENEGA CREEK - NEAR AGUA VERDE WASH	CC Below Davidson	5/23/1989
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	7/25/1989
CIENEGA CREEK - AT TILTED BEDS	CC Above Davidson	7/25/1989
CIENEGA CREEK - NEAR AGUA VERDE WASH	CC Below Davidson	7/25/1989
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	9/24/1989
CIENEGA CREEK - AT TILTED BEDS	CC Above Davidson	9/24/1989
CIENEGA CREEK - NEAR AGUA VERDE WASH	CC Below Davidson	9/24/1989
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	11/21/1989
CIENEGA CREEK - AT TILTED BEDS	CC Above Davidson	11/21/1989
CIENEGA CREEK - NEAR AGUA VERDE WASH	CC Below Davidson	11/21/1989
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	1/31/1990
CIENEGA CREEK - AT TILTED BEDS	CC Above Davidson	1/31/1990
CIENEGA CREEK - NEAR AGUA VERDE WASH	CC Below Davidson	1/31/1990
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	3/27/1990
CIENEGA CREEK - AT TILTED BEDS	CC Above Davidson	3/27/1990
CIENEGA CREEK - NEAR AGUA VERDE WASH	CC Below Davidson	3/27/1990
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	5/30/1990
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	7/10/1990
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	10/1/1990
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	11/13/1990
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	11/14/1990

Sample Location	General Location	Date
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	1/14/1991
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	3/6/1991
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	5/28/1991
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	7/16/1991
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	9/25/1991
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	11/20/1991
CIENEGA CREEK - AT STEVENSON CANYON	CC Above Davidson	11/26/1991
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	1/30/1992
CIENEGA CREEK - AT STEVENSON CANYON	CC Above Davidson	1/31/1992
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	3/19/1992
CIENEGA CREEK - ABOVE THE NARROWS	CC Above Davidson	4/17/1992
CIENEGA CREEK - AT STEVENSON CANYON	CC Above Davidson	5/14/1992
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	5/27/1992
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	7/20/1992
CIENEGA CREEK - AT STEVENSON CANYON	CC Above Davidson	8/6/1992
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	9/18/1992
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	11/6/1992
CIENEGA CREEK - AT TILTED BEDS	CC Above Davidson	11/6/1992
CIENEGA CREEK - AT STEVENSON CANYON	CC Above Davidson	11/14/1992
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	2/16/1993
CIENEGA CREEK - AT STEVENSON CANYON	CC Above Davidson	3/16/1993
CIENEGA CREEK - ABOVE THE NARROWS	CC Above Davidson	4/16/1993
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	4/21/1993
CIENEGA CREEK - AT TILTED BEDS	CC Above Davidson	4/21/1993
CIENEGA CREEK - AT STEVENSON CANYON	CC Above Davidson	5/27/1993
CIENEGA CREEK - AT STEVENSON CANYON	CC Above Davidson	8/18/1993
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	8/25/1993
CIENEGA CREEK - AT STEVENSON CANYON	CC Above Davidson	11/22/1993
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	11/29/1993
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	1/25/1994
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	3/10/1994
CIENEGA CREEK - ABOVE THE NARROWS	CC Above Davidson	4/21/1994
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	5/25/1994
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	8/1/1994
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	9/27/1994
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	11/30/1994
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	3/17/1995
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	5/17/1995
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	7/20/1995

Sample Location	General Location	Date
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	9/27/1995
CIENEGA CREEK - ABOVE THE NARROWS	CC Above Davidson	5/31/1996
CIENEGA CREEK - ABOVE DAVIDSON CANYON	CC Above Davidson	9/28/1998
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	9/28/1998
CIENEGA CREEK - ABOVE DIVERSION DAM	CC Below Davidson	9/29/1998
CIENEGA CREEK - BELOW TILTED BEDS	CC Above Davidson	9/29/1998
CIENEGA CREEK - BELOW SANDFORD CANYON	CC Above Davidson	9/30/1998
CIENEGA CREEK - BELOW STEVENSON CANYON	CC Above Davidson	9/30/1998
CIENEGA CREEK - AT CEDAR CANYON	CC Above Davidson	12/11/2000
CIENEGA CREEK - BELOW PUMP CANYON	CC Above Davidson	12/11/2000
CIENEGA CREEK - SW OF BENCHMARK 3490	CC Above Davidson	12/11/2000
CIENEGA CREEK - ABOVE DAVIDSON CANYON, SE OF BENCHMARK 3365	CC Above Davidson	12/12/2000
CIENEGA CREEK - SW OF BENCHMARK 3490	CC Above Davidson	12/12/2000
CIENEGA CREEK - AT CEDAR CANYON	CC Above Davidson	2/16/2001
CIENEGA CREEK - BELOW PUMP CANYON	CC Above Davidson	2/16/2001
CIENEGA CREEK - ABOVE DAVIDSON CANYON, SE OF BENCHMARK 3365	CC Above Davidson	2/22/2001
CIENEGA CREEK - SW OF BENCHMARK 3490	CC Above Davidson	2/22/2001
CIENEGA CREEK - AT CEDAR CANYON	CC Above Davidson	3/24/2001
CIENEGA CREEK - ABOVE DAVIDSON CANYON, SE OF BENCHMARK 3365	CC Above Davidson	4/17/2001
CIENEGA CREEK - SW OF BENCHMARK 3490	CC Above Davidson	4/17/2001
CIENEGA CREEK - BELOW PUMP CANYON	CC Above Davidson	4/18/2001
CIENEGA CREEK - AT CEDAR CANYON	CC Above Davidson	4/19/2001
CIENEGA CREEK - BELOW PUMP CANYON	CC Above Davidson	4/20/2001
CIENEGA CREEK - AT CEDAR CANYON	CC Above Davidson	7/19/2001
CIENEGA CREEK - ABOVE DAVIDSON CANYON, SE OF BENCHMARK 3365	CC Above Davidson	9/18/2001
CIENEGA CREEK - AT CEDAR CANYON	CC Above Davidson	9/18/2001
CIENEGA CREEK - BELOW PUMP CANYON	CC Above Davidson	9/18/2001
CIENEGA CREEK - SW OF BENCHMARK 3490	CC Above Davidson	9/18/2001
CIENEGA CREEK - ABOVE DAVIDSON CANYON, SE OF BENCHMARK 3365	CC Above Davidson	12/17/2001
CIENEGA CREEK - AT CEDAR CANYON	CC Above Davidson	12/17/2001
CIENEGA CREEK - BELOW PUMP CANYON	CC Above Davidson	12/17/2001
CIENEGA CREEK - SW OF BENCHMARK 3490	CC Above Davidson	12/17/2001
CIENEGA CREEK - ABOVE DAVIDSON CANYON, SE OF BENCHMARK 3365	CC Above Davidson	3/20/2002
CIENEGA CREEK - AT CEDAR CANYON	CC Above Davidson	3/20/2002

Sample Location	General Location	Date
CIENEGA CREEK - BELOW PUMP CANYON	CC Above Davidson	3/20/2002
CIENEGA CREEK - SW OF BENCHMARK 3490	CC Above Davidson	3/20/2002
Davidson 1	Davidson	6/4/2002
Davidson 2	Davidson	6/4/2002
Davidson 1	Davidson	8/2/2002
Davidson 2	Davidson	10/3/2002
Davidson 2	Davidson	1/3/2003
Davidson 1	Davidson	5/8/2003
CIENEGA CREEK - ABOVE DAVIDSON CANYON, SE OF BENCHMARK 3365	CC Above Davidson	9/26/2005
CIENEGA CREEK - AT STEVENSON CANYON	CC Above Davidson	9/27/2005
CIENEGA CREEK - ABOVE DAVIDSON CANYON, SE OF BENCHMARK 3365	CC Above Davidson	12/6/2005
CIENEGA CREEK - AT STEVENSON CANYON	CC Above Davidson	12/7/2005
CIENEGA CREEK - ABOVE DAVIDSON CANYON, SE OF BENCHMARK 3365	CC Above Davidson	2/14/2006
CIENEGA CREEK - AT STEVENSON CANYON	CC Above Davidson	2/16/2006
CIENEGA CREEK - ABOVE DAVIDSON CANYON, SE OF BENCHMARK 3365	CC Above Davidson	4/10/2006
CIENEGA CREEK - AT STEVENSON CANYON	CC Above Davidson	4/12/2006
Lower Cienega Creek	CC Below Davidson	6/24/2008
Upper Cienega Creek	CC Above Davidson	6/24/2008
Upper Cienega Creek dup	CC Above Davidson	6/24/2008
Factory 125	BC - Rosemont Junction	7/9/2008
Factory 1251	BC - Rosemont Junction	7/9/2008
Factory125	BC - Rosemont Junction	7/9/2008
Factory 125	BC - Rosemont Junction	7/11/2008
Factory125	BC - Rosemont Junction	7/11/2008
CIENEGA CREEK - ABOVE THE NARROWS	CC Above Davidson	8/19/2008
Upper Cienega Creek	CC Above Davidson	10/21/2008
Lower Cienega Creek	CC Below Davidson	10/22/2008
Lower Davidson Creek	Davidson	10/22/2008
Junction	BC - Rosemont Junction	7/1/2009
RP2	BC - Compliance Point Dam	7/1/2009
Junction	BC - Rosemont Junction	7/21/2009
RP2	BC - Compliance Point Dam	7/21/2009
Junction 1	BC - Rosemont Junction	7/23/2009
Junction1	BC - Rosemont Junction	7/23/2009

Sample Location	General Location	Date
Junction	BC - Rosemont Junction	9/4/2009
RP2	BC - Compliance Point Dam	9/4/2009
Junction	BC - Rosemont Junction	9/6/2009
RP2	BC - Compliance Point Dam	9/6/2009
PSW 1A/B	BC - Upper Barrel Canyon	1/20/2010
PSW 2	BC - Wasp Canyon	1/20/2010
PSW 2B	BC - Wasp Canyon	1/20/2010
PSW 3	BC - Rosemont Junction	1/20/2010
PSW 1	BC - Upper Barrel Canyon	1/22/2010
PSW 2	BC - Wasp Canyon	1/22/2010
PSW 3	BC - Rosemont Junction	1/22/2010
PSW 4	BC - McCleary Canyon	1/22/2010
PSW 5	BC - Compliance Point Dam	1/22/2010
PSW 6	BC - Scholefield Canyon	1/22/2010
PSW1	BC - Upper Barrel Canyon	1/22/2010
PSW2	BC - Wasp Canyon	1/22/2010
PSW3	BC - Rosemont Junction	1/22/2010
PSW4	BC - McCleary Canyon	1/22/2010
PSW5	BC - Compliance Point Dam	1/22/2010
PSW6	BC - Scholefield Canyon	1/22/2010
PSW 1A	BC - Upper Barrel Canyon	3/1/2010
PSW 1B	BC - Upper Barrel Canyon	3/1/2010
PSW 2A	BC - Wasp Canyon	3/1/2010
PSW 2B	BC - Wasp Canyon	3/1/2010
PSW 4	BC - McCleary Canyon	3/1/2010
PSW 1A/B	BC - Upper Barrel Canyon	8/11/2010
PSW 2B	BC - Wasp Canyon	8/11/2010
PSW 4	BC - McCleary Canyon	8/11/2010
PSW 5	BC - Compliance Point Dam	8/11/2010
PSW 6	BC - Scholefield Canyon	8/11/2010
PSW1A/B	BC - Upper Barrel Canyon	8/11/2010
PSW5	BC - Compliance Point Dam	8/11/2010
PSW6	BC - Scholefield Canyon	8/11/2010
PSW 2A/2B	BC - Wasp Canyon	7/21/2011

Sample Location	General Location	Date
PSW 3A/3B	BC - Rosemont Junction	7/21/2011
PSW2A/2B	BC - Wasp Canyon	7/21/2011
PSW3A/3B	BC - Rosemont Junction	7/21/2011
PSW5	BC - Compliance Point Dam	7/21/2011
PSW 1A/1B	BC - Upper Barrel Canyon	8/3/2011
PSW 2A/2B	BC - Wasp Canyon	8/3/2011
PSW 3A/3B	BC - Rosemont Junction	8/3/2011
PSW 5A/5B	BC - Compliance Point Dam	8/3/2011
PSW1A/1B	BC - Upper Barrel Canyon	8/3/2011
PSW2A/2B	BC - Wasp Canyon	8/3/2011
PSW3A/3B	BC - Rosemont Junction	8/3/2011
PSW5A/5B	BC - Compliance Point Dam	8/3/2011
PSW 1A	BC - Upper Barrel Canyon	9/7/2011
PSW 2A/2B	BC - Wasp Canyon	9/7/2011
PSW1A	BC - Upper Barrel Canyon	9/7/2011
PSW1B	BC - Upper Barrel Canyon	9/7/2011
PSW2A/2B	BC - Wasp Canyon	9/7/2011
PSW3A/3B	BC - Rosemont Junction	9/7/2011
PSW 1	BC - Upper Barrel Canyon	9/11/2011
PSW 2A/2B	BC - Wasp Canyon	9/11/2011
PSW 3A/3B	BC - Rosemont Junction	9/11/2011
PSW 4A/4B	BC - McCleary Canyon	9/11/2011
PSW 5A/5B	BC - Compliance Point Dam	9/11/2011
PSW 6	BC - Scholefield Canyon	9/11/2011
PSW1	BC - Upper Barrel Canyon	9/11/2011
PSW2A/2B	BC - Wasp Canyon	9/11/2011
PSW3A/3B	BC - Rosemont Junction	9/11/2011
PSW5A/5B	BC - Compliance Point Dam	9/11/2011
PSW6	BC - Scholefield Canyon	9/11/2011
PWS 4A/4B	BC - McCleary Canyon	9/11/2011
PWS4A/4B	BC - McCleary Canyon	9/11/2011
PSW 6	BC - Scholefield Canyon	9/12/2011
PSW6	BC - Scholefield Canyon	9/12/2011
PSW 6	BC - Scholefield Canyon	9/14/2011
PSW6	BC - Scholefield Canyon	9/14/2011

Sample Location	General Location	Date
CIENEGA CREEK - BETWEEN SITES 100480 AND 101177		8/30/2012
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	9/10/2012
DAVIDSON CANYON - AT OAW SPRING SOURCE	Davidson	9/10/2012
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	11/20/2012
DAVIDSON CANYON - AT OAW SPRING SOURCE	Davidson	11/20/2012
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	2/27/2013
CIENEGA CREEK - AT MARSH STATION ROAD	CC Below Davidson	4/18/2013

ATTACHMENT B

COMPARISON OF SURFACE WATER QUALITY DATES TO EVIDENCE FOR STORMFLOW

This attachment contains a compilation of evidence to determine whether any water quality samples available for Cienega Creek or Davidson Canyon possibly represent stormflow, instead of baseflow. The following information was reviewed:

- USGS Gaging Station 09484550 on Cienega Creek. Graphs of data for sampling dates are attached in this appendix. Available from http://waterdata.usgs.gov/nwis/sw.

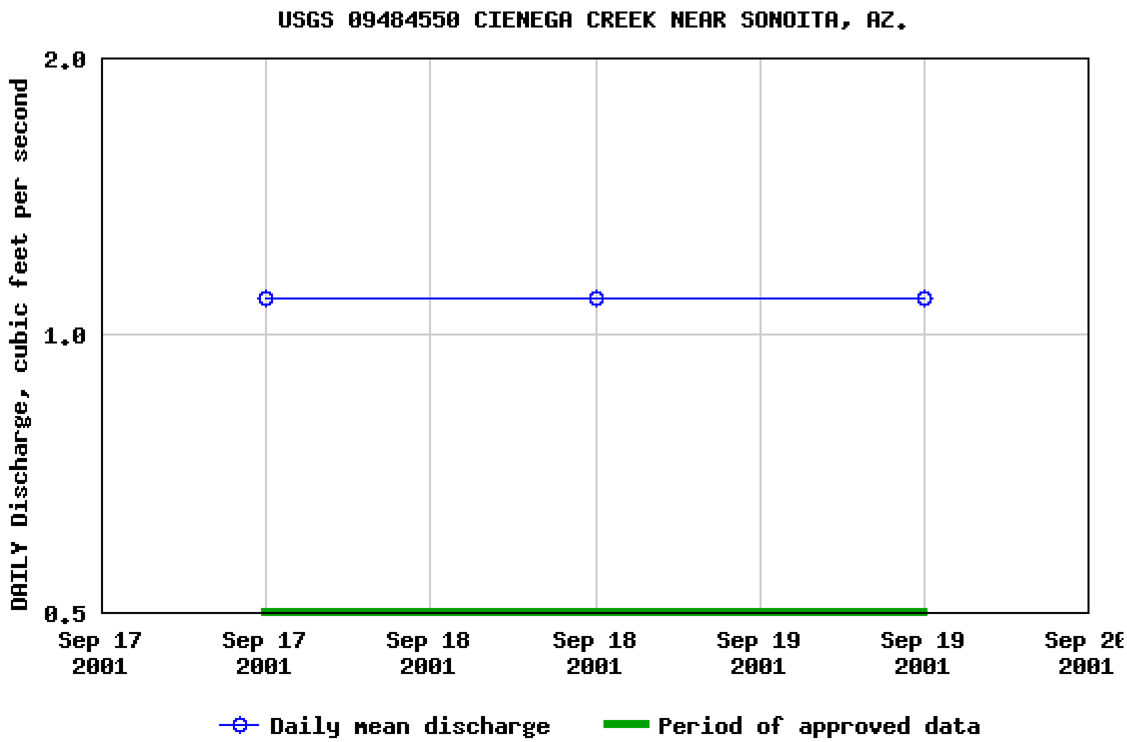
- USGS Gaging Station 09484580 on Barrel Canyon. Graphs of data for sampling dates are attached in this appendix. Available from http://waterdata.usgs.gov/nwis/sw. One sampling date was flagged as possibly representing stormflow , not baseflow (9/10/12). Samples were collected on this date at on Cienega Creek at Marsh Station Road and in Davidson Canyon.

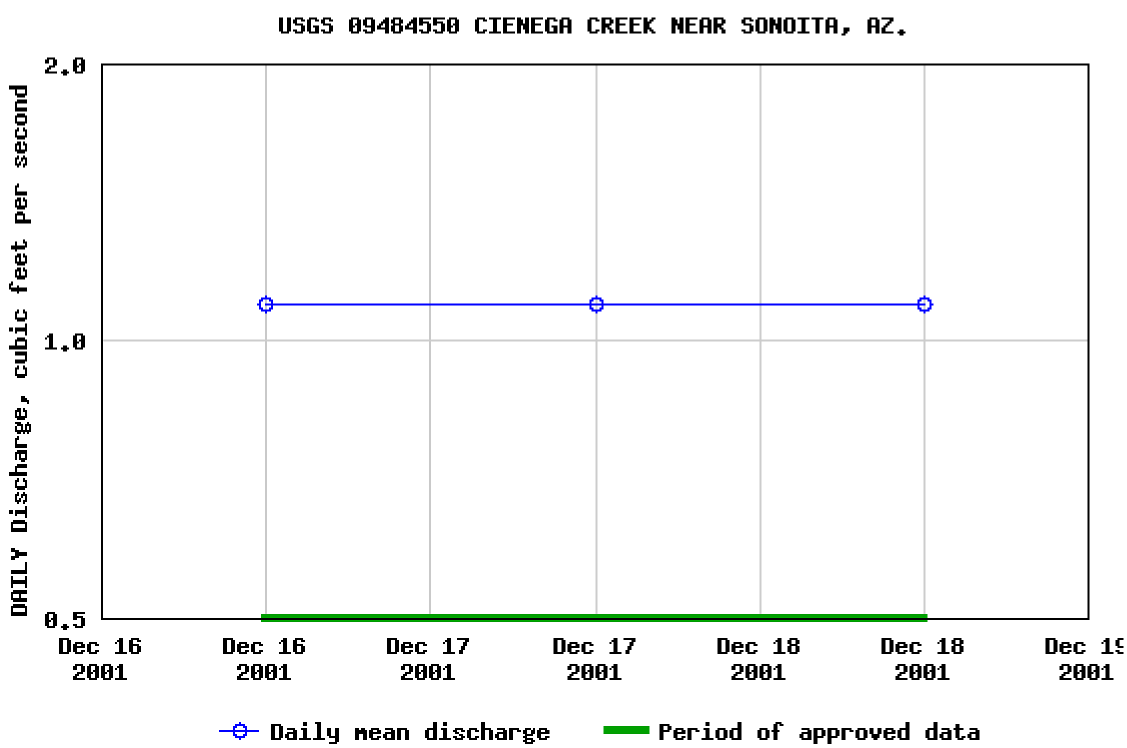
- Review of Pima County Flood Control District ALERT data, stations 4250, 4280, 4310, and 4320. Available from http://alert.rfcd.pima.gov/perl/Pima.pl. See attached matrix for summary of review. One sampling date was flagged as possibly representing stormflow, not baseflow (9/10/12). Samples were collected on this date at on Cienega Creek at Marsh Station Road and in Davidson Canyon.

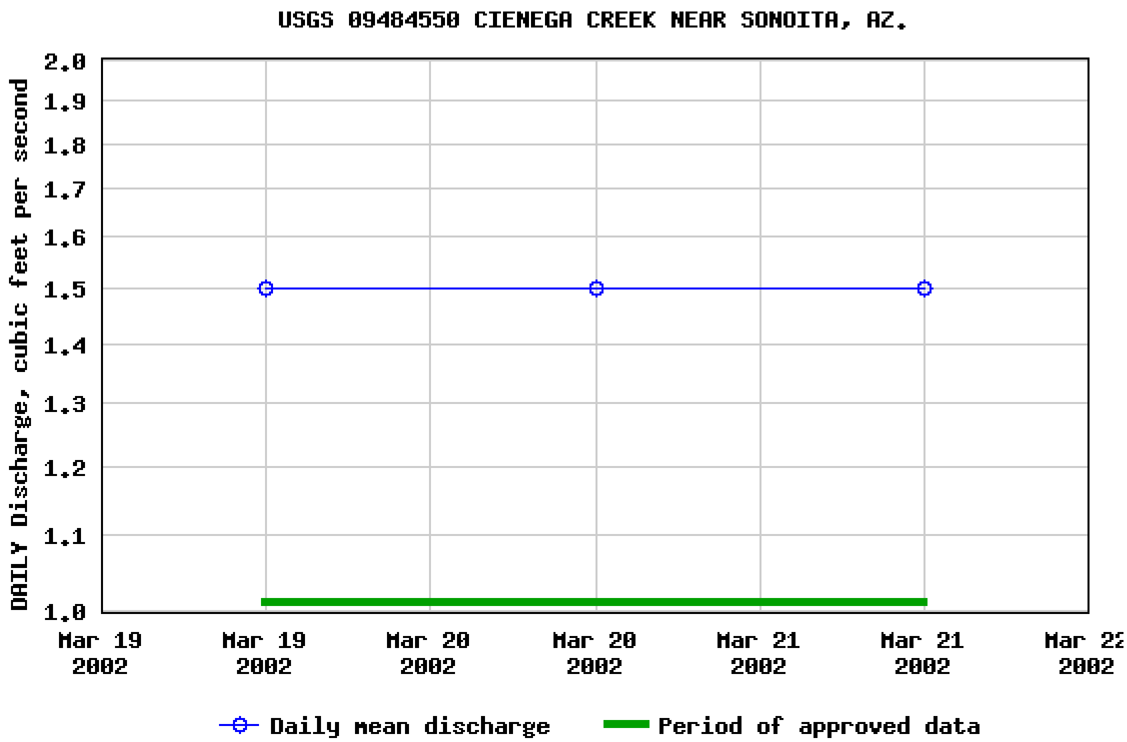
- Rosemont on-site precipitation data. The period of record for the Rosemont meteorological station did not match the time period during which water quality samples were collected.

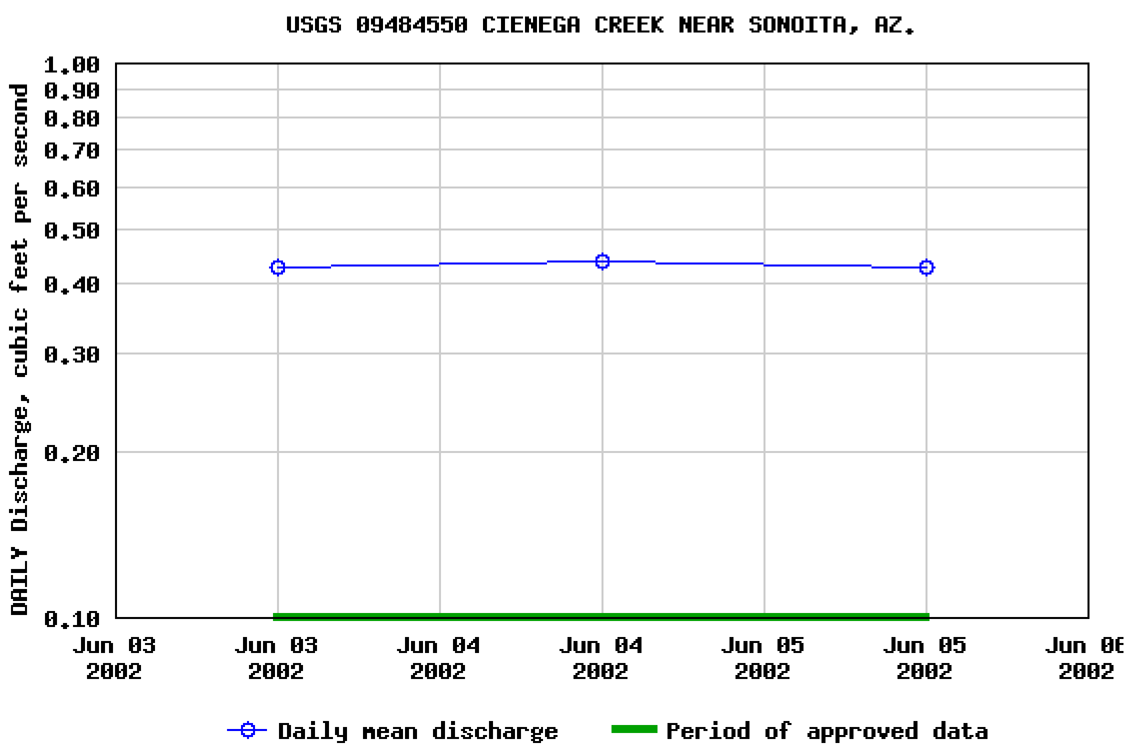
- Field flow measurements. Water quality samples compiled by ADEQ and USEPA have flow measurements recorded. These have been reviewed and are captured in the attached matrix. One sampling date was flagged as possibly representing stormflow, not baseflow (7/20/88). This sample was collected on Cienega Creek at Marsh Station Road, which is below Davidson Canyon.

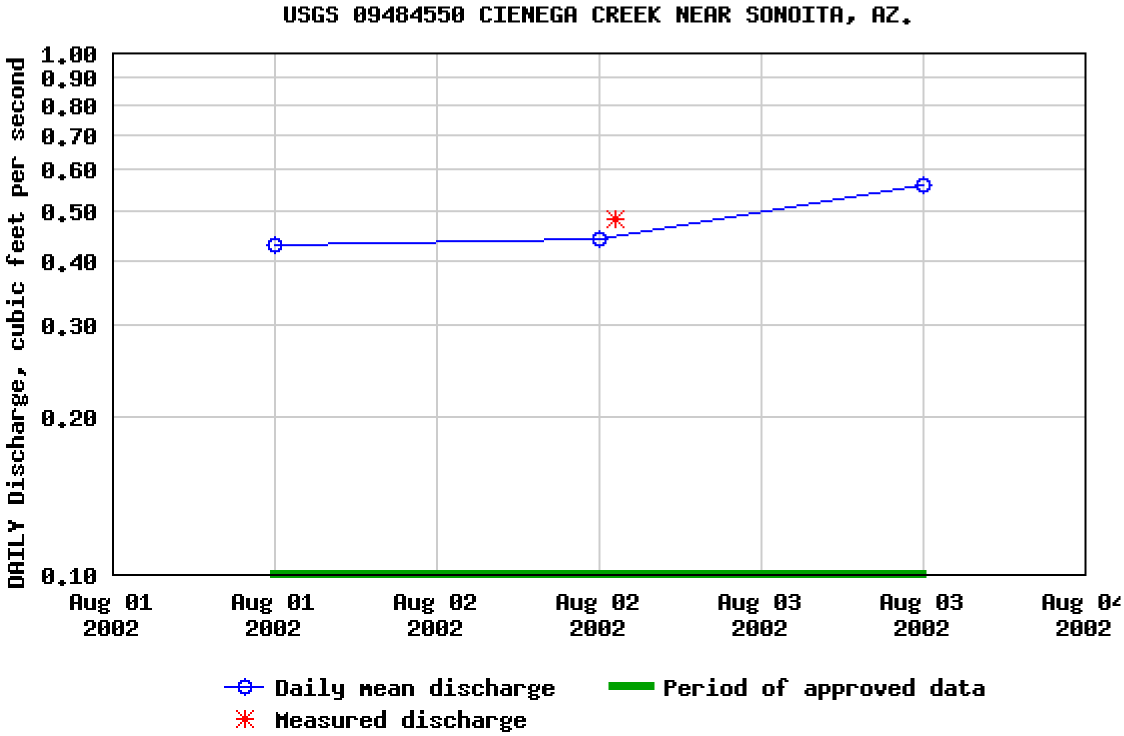
HYDROGRAPHS FROM USGS GAGE 09484550



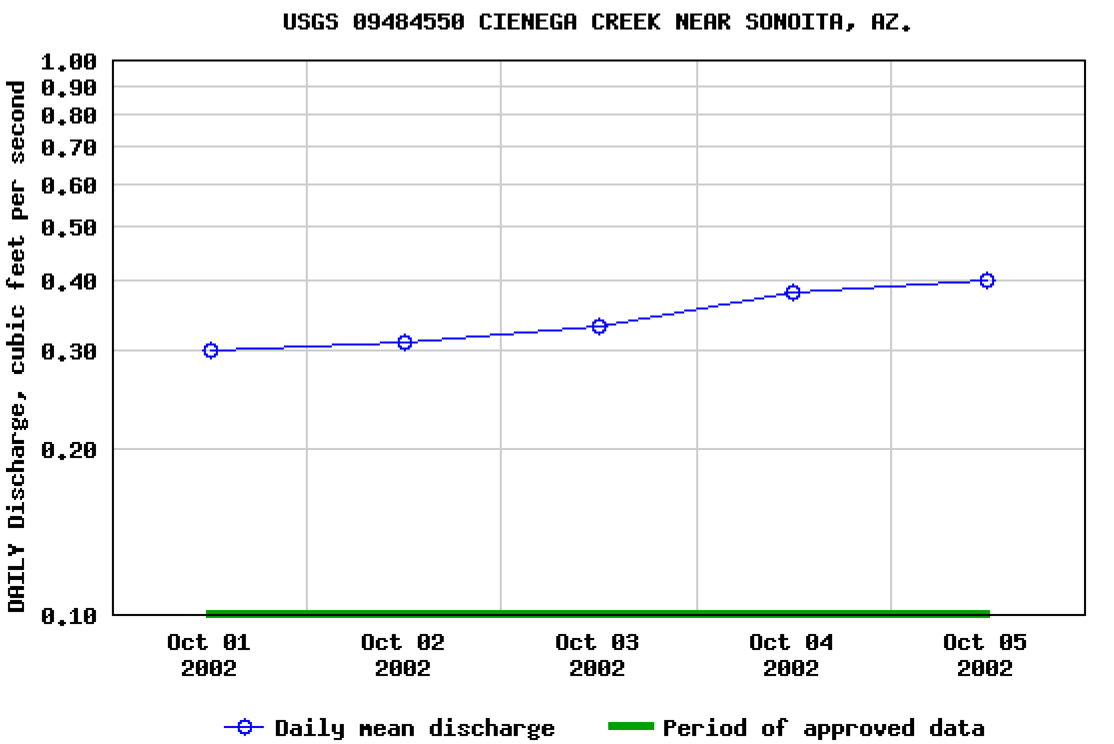



USGS 09484550 CIENEGA CREEK NEAR SONOITA, AZ.
DAILY Discharge, cubic feet per second
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
Mar 19 2002
Mar 19 2002
Mar 20 2002
Mar 20 2002
Mar 21 2002
Mar 21 2002
Mar 22 2002
Daily mean discharge
Period of approved data

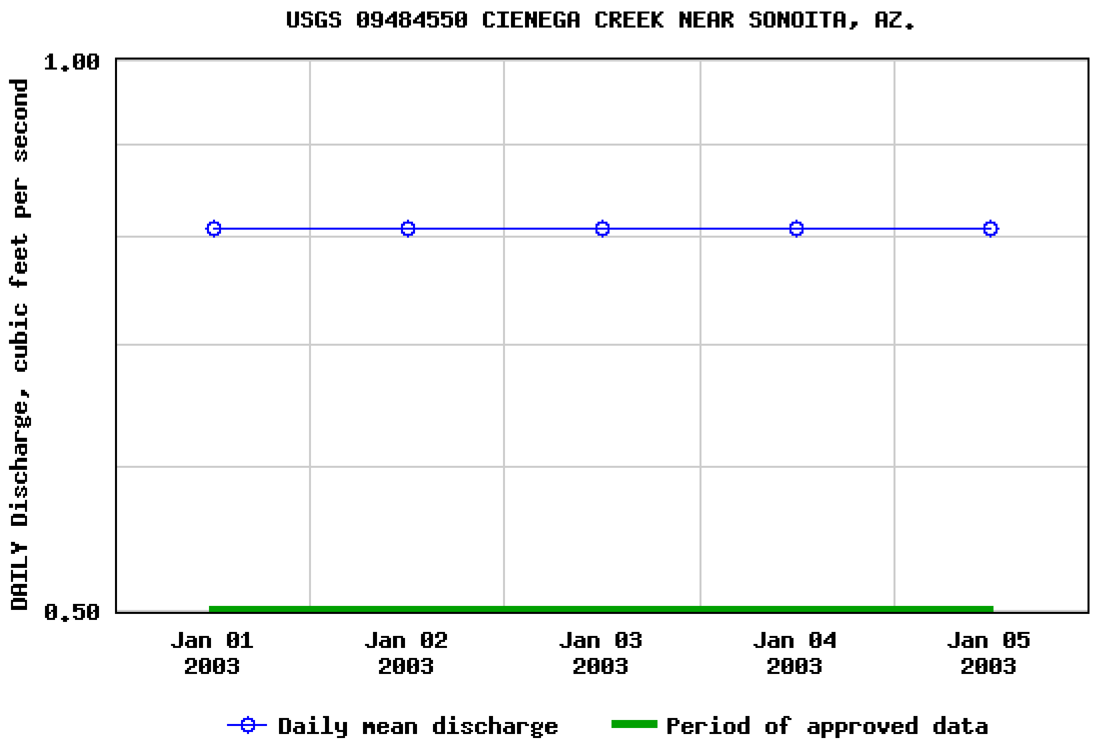

USGS 09484550 CIENEGA CREEK NEAR SONOITA, AZ.
DAILY Discharge, cubic feet per second
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
Jun 03 2002
Jun 03 2002
Jun 04 2002
Jun 04 2002
Jun 05 2002
Jun 05 2002
Jun 06 2002
Daily mean discharge
Period of approved data

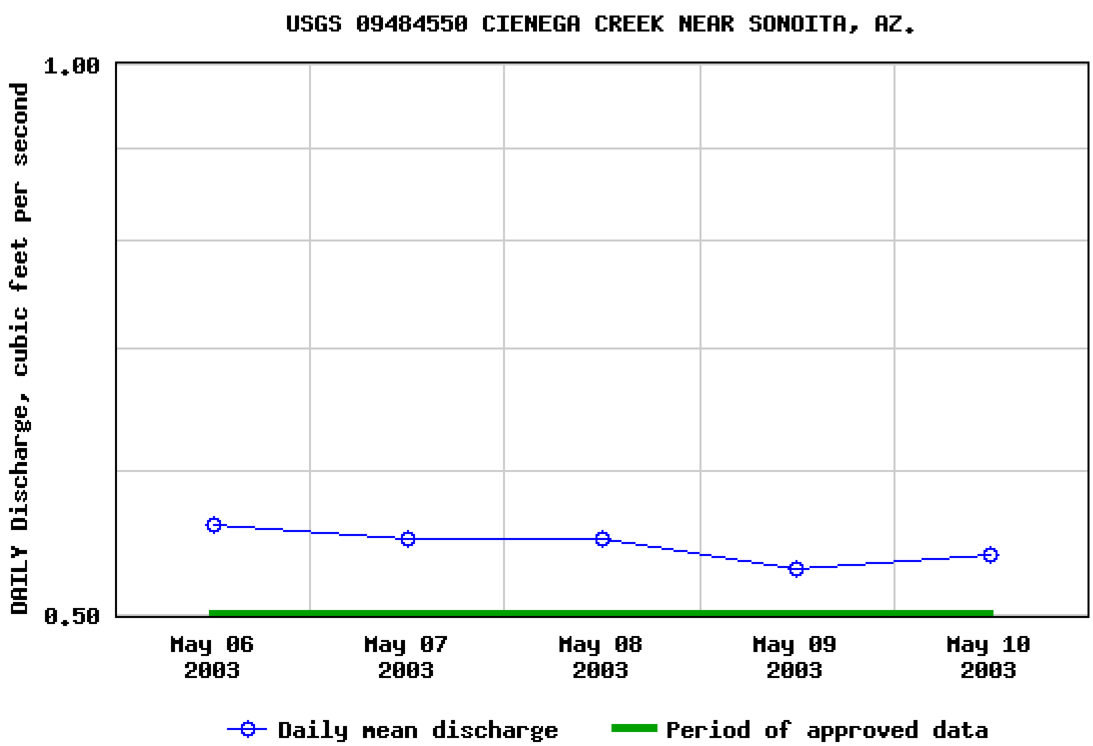


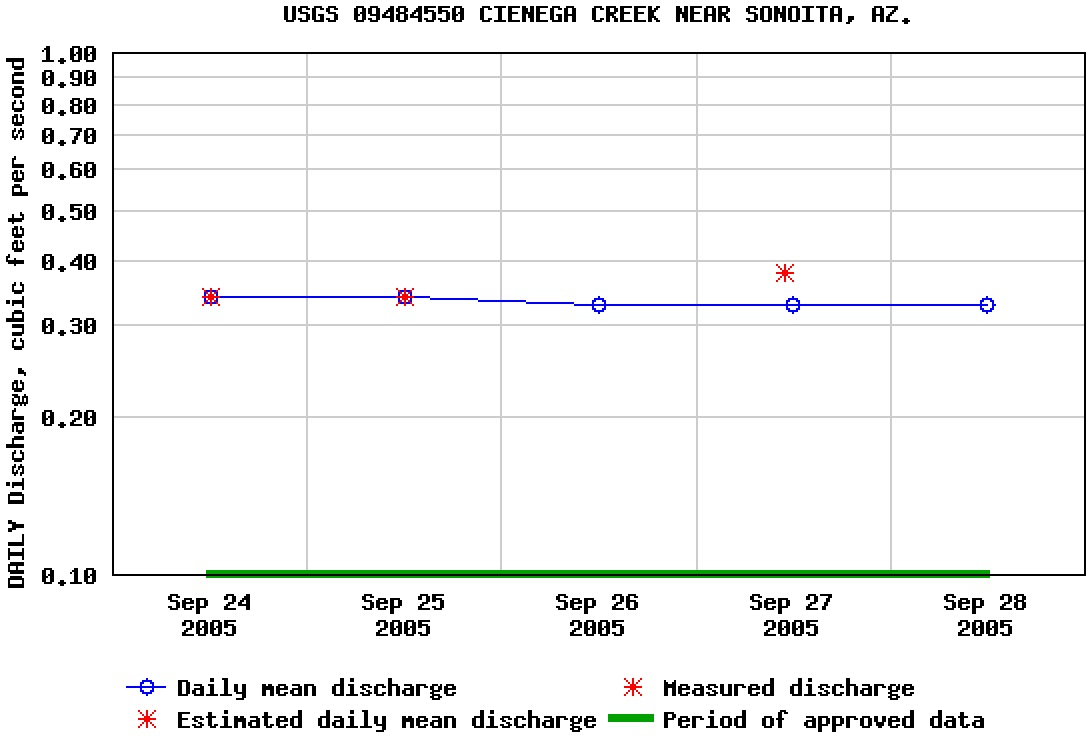
USGS 09484550 CIENEGA CREEK NEAR SONOITA, AZ.
DAILY Discharge, cubic feet per second
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
Aug 01 2002
Aug 01 2002
Aug 02 2002
Aug 02 2002
Aug 03 2002
Aug 03 2002
Aug 04 2002
Daily mean discharge
Period of approved data
Measured discharge

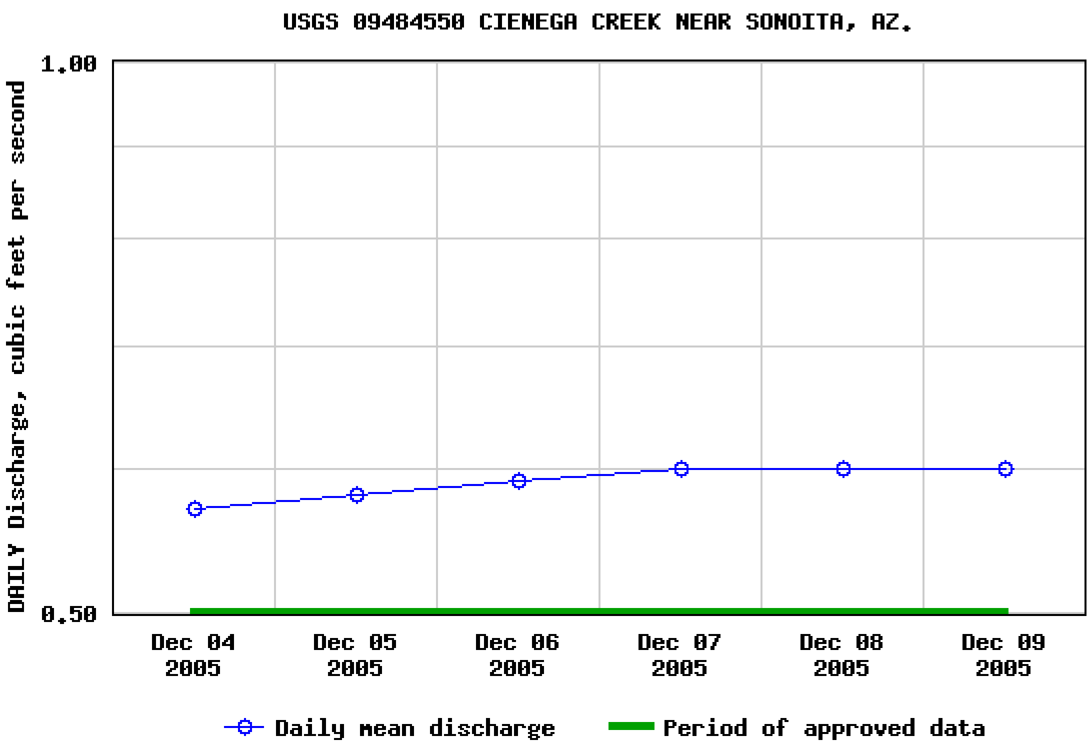


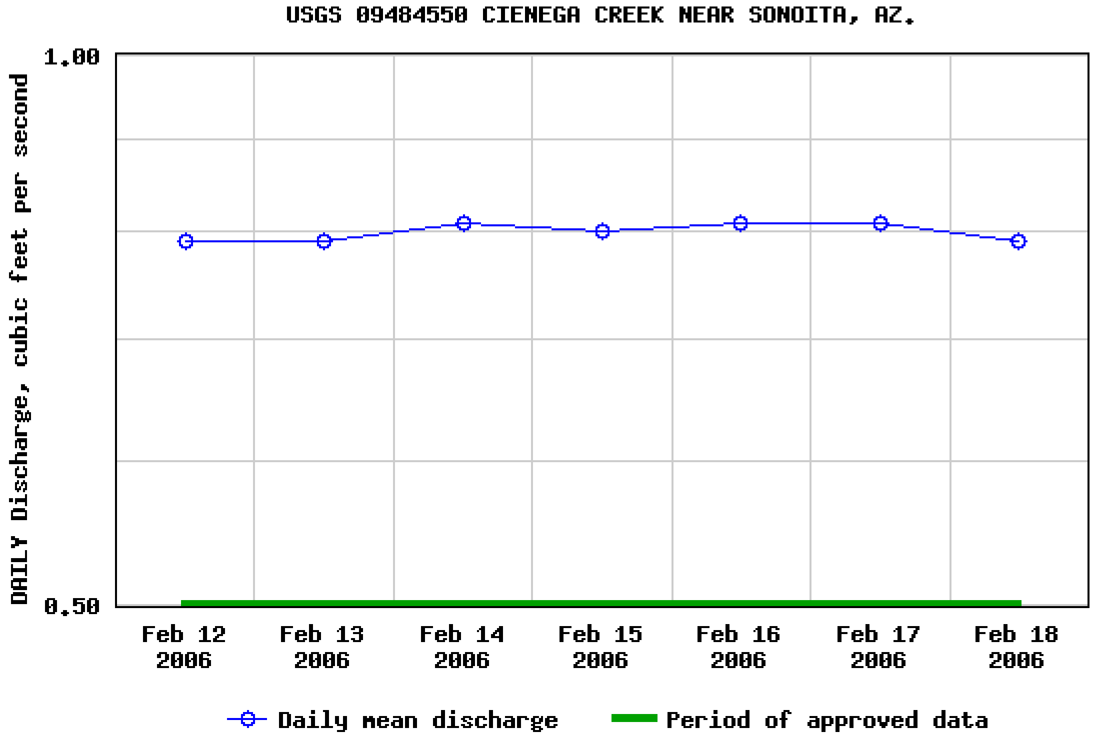
USGS 09484550 CIENEGA CREEK NEAR SONOITA, AZ.
DAILY Discharge, cubic feet per second
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
Oct 01 2002
Oct 02 2002
Oct 03 2002
Oct 04 2002
Oct 05 2002
Daily mean discharge
Period of approved data

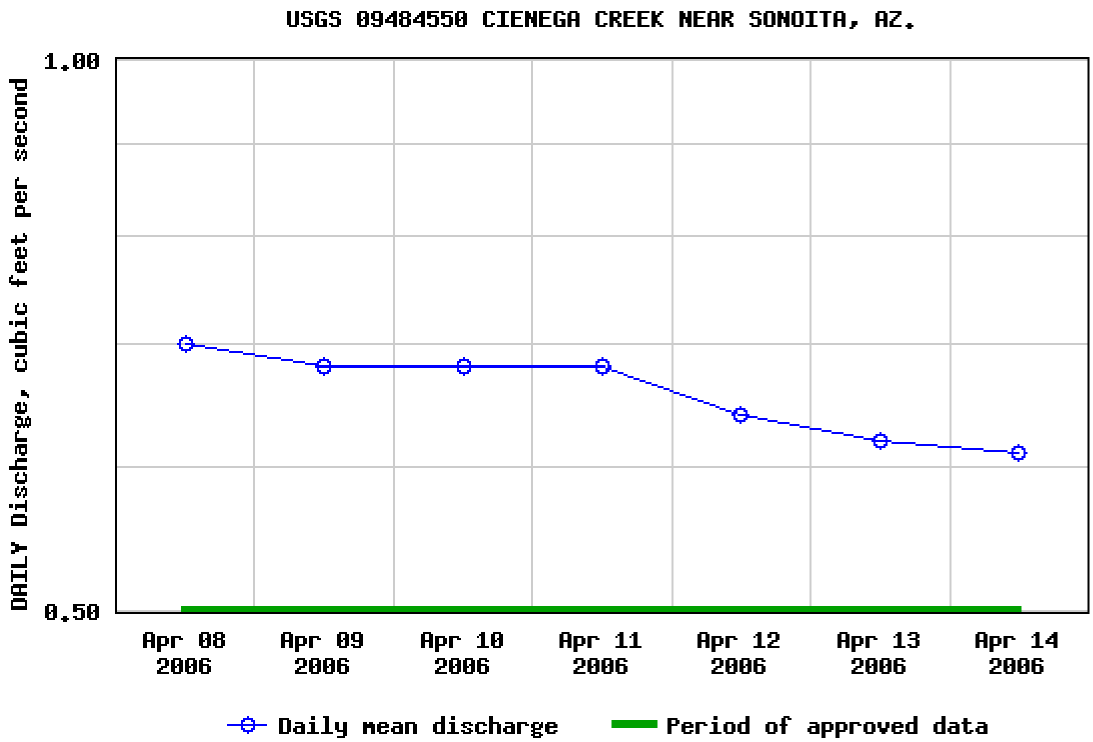

USGS 09484550 CIENEGA CREEK NEAR SONOITA, AZ.
DAILY Discharge, cubic feet per second
1.00
0.50
Jan 01 2003
Jan 02 2003
Jan 03 2003
Jan 04 2003
Jan 05 2003
Daily mean discharge
Period of approved data

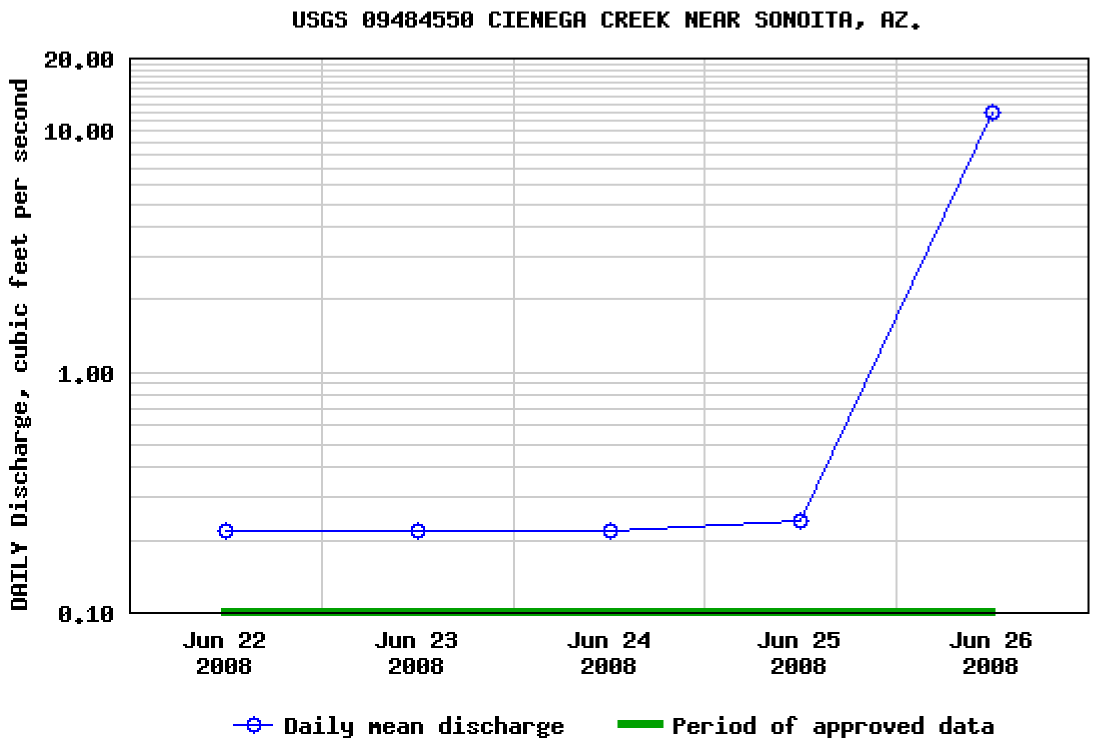

USGS 09484550 CIENEGA CREEK NEAR SONOITA, AZ.
DAILY Discharge, cubic feet per second
1.00
0.50
May 06 2003
May 07 2003
May 08 2003
May 09 2003
May 10 2003
Daily mean discharge
Period of approved data


USGS 09484550 CIENEGA CREEK NEAR SONOITA, AZ.
DAILY Discharge, cubic feet per second
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
Sep 24 2005
Sep 25 2005
Sep 26 2005
Sep 27 2005
Sep 28 2005
Daily mean discharge
Measured discharge
Estimated daily mean discharge
Period of approved data

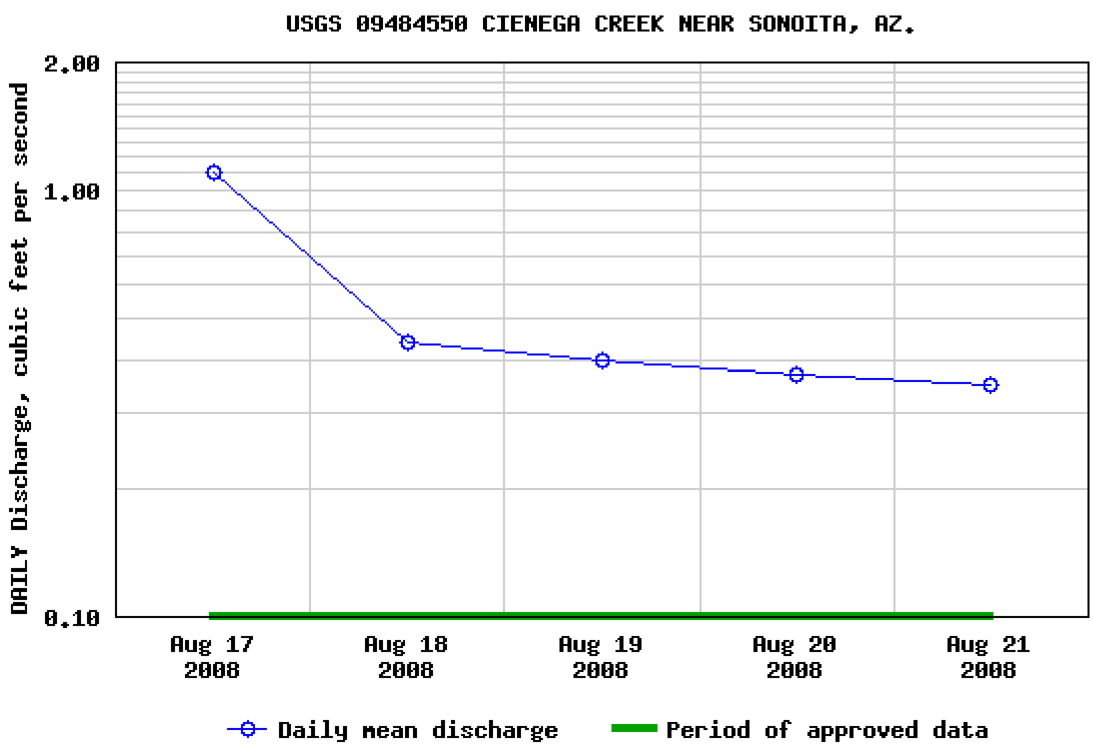

USGS 09484550 CIENEGA CREEK NEAR SONOITA, AZ.
DAILY Discharge, cubic feet per second
1.00
0.50
Dec 04 2005
Dec 05 2005
Dec 06 2005
Dec 07 2005
Dec 08 2005
Dec 09 2005
Daily mean discharge
Period of approved data


USGS 09484550 CIENEGA CREEK NEAR SONOITA, AZ.
DAILY Discharge, cubic feet per second
1.00
0.50
Feb 12 2006
Feb 13 2006
Feb 14 2006
Feb 15 2006
Feb 16 2006
Feb 17 2006
Feb 18 2006
Daily mean discharge
Period of approved data

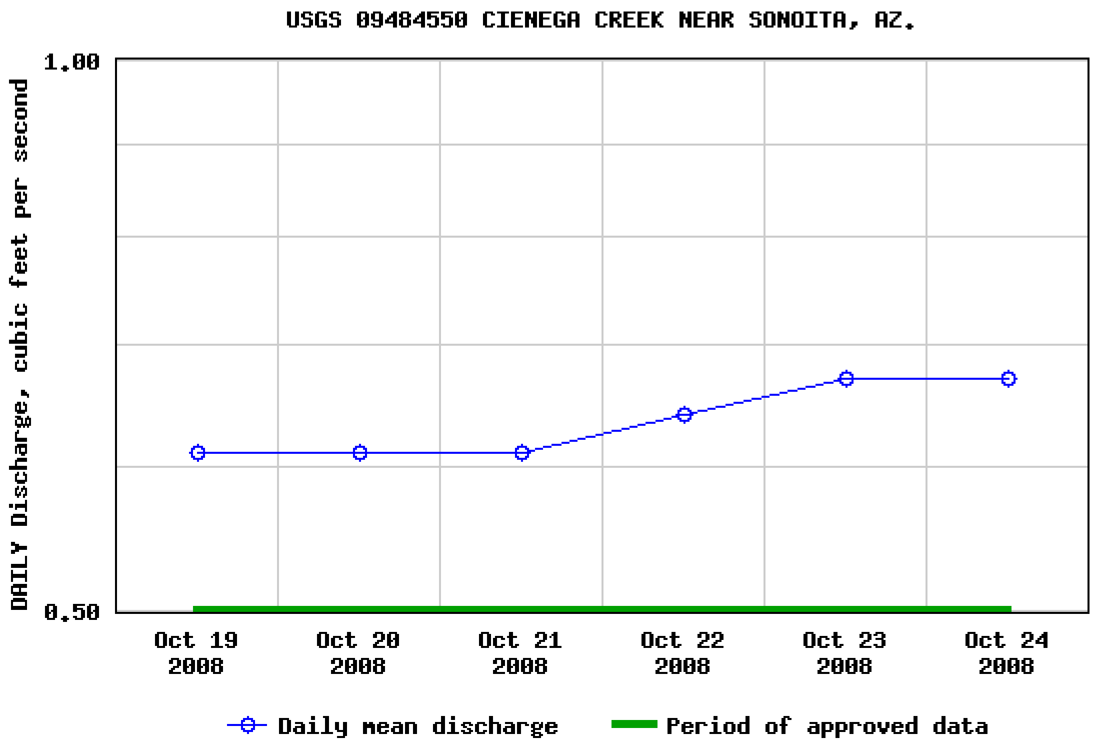

USGS 09484550 CIENEGA CREEK NEAR SONOITA, AZ.
DAILY Discharge, cubic feet per second
1.00
0.50
Apr 08 2006
Apr 09 2006
Apr 10 2006
Apr 11 2006
Apr 12 2006
Apr 13 2006
Apr 14 2006
Daily mean discharge
Period of approved data

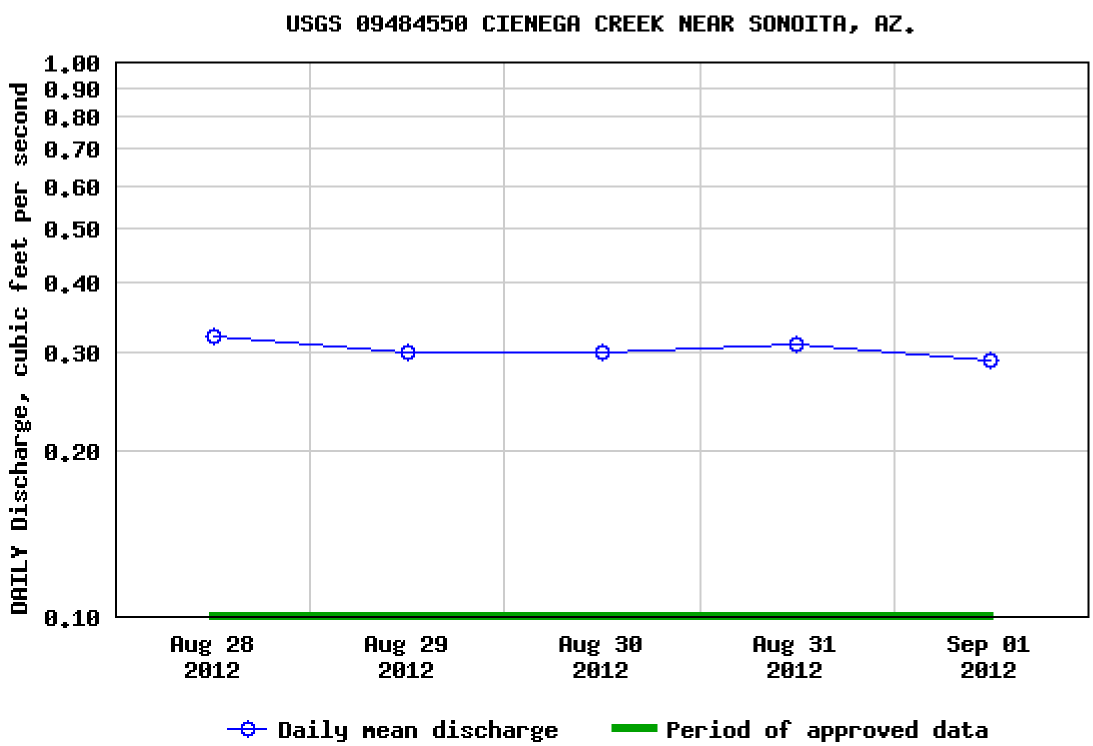


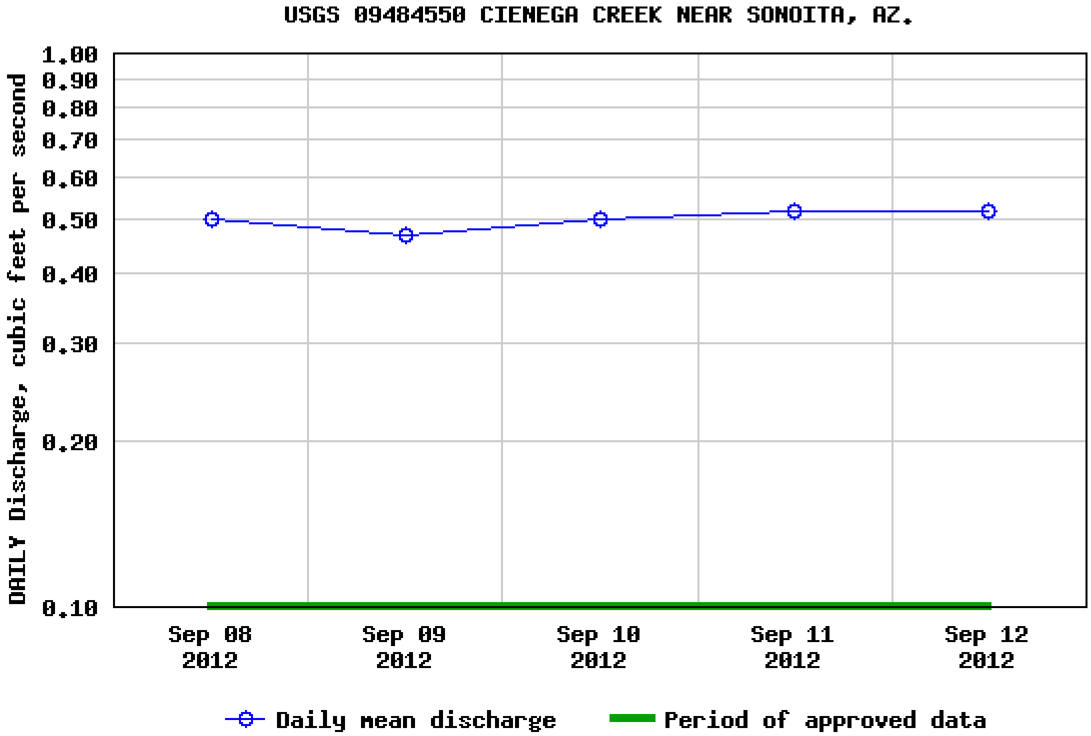
USGS 09484550 CIENEGA CREEK NEAR SONOITA, AZ.
20.00
10.00
1.00
0.10
DAILY Discharge, cubic feet per second
Jun 22 2008
Jun 23 2008
Jun 24 2008
Jun 25 2008
Jun 26 2008
Daily mean discharge
Period of approved data



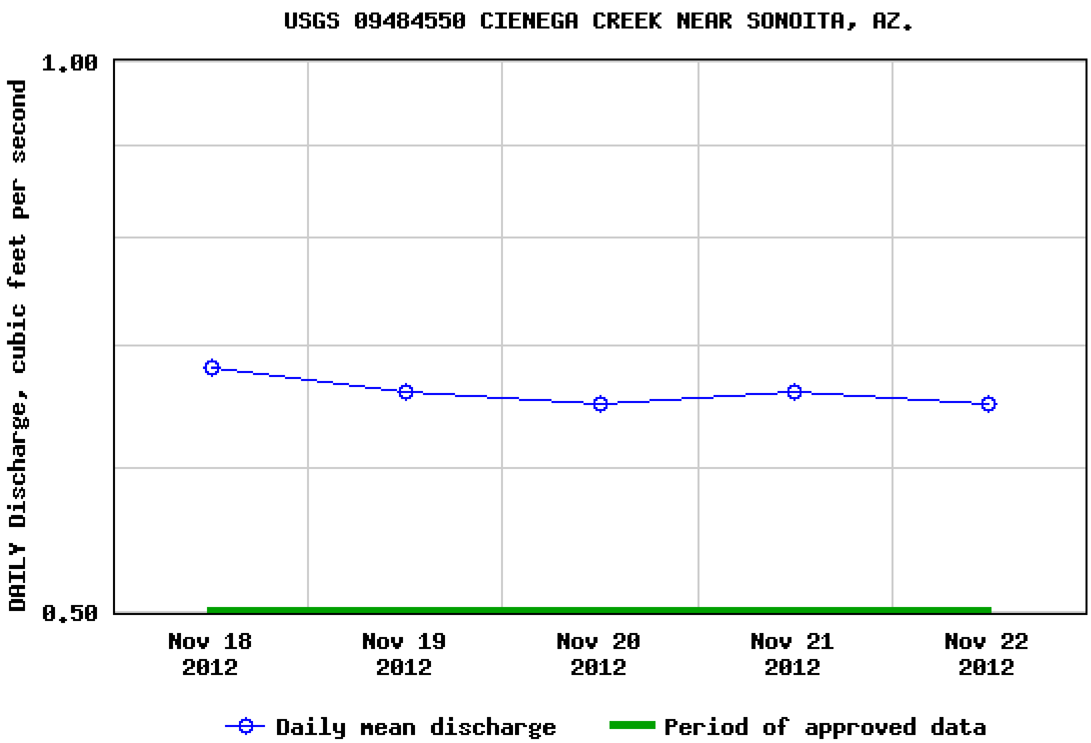
USGS 09484550 CIENEGA CREEK NEAR SONOITA, AZ.
2.00
1.00
0.10
DAILY Discharge, cubic feet per second
Aug 17 2008
Aug 18 2008
Aug 19 2008
Aug 20 2008
Aug 21 2008
Daily mean discharge
Period of approved data


USGS 09484550 CIENEGA CREEK NEAR SONOITA, AZ.
DAILY Discharge, cubic feet per second
1.00
0.50
Oct 19 2008
Oct 20 2008
Oct 21 2008
Oct 22 2008
Oct 23 2008
Oct 24 2008
Daily mean discharge
Period of approved data

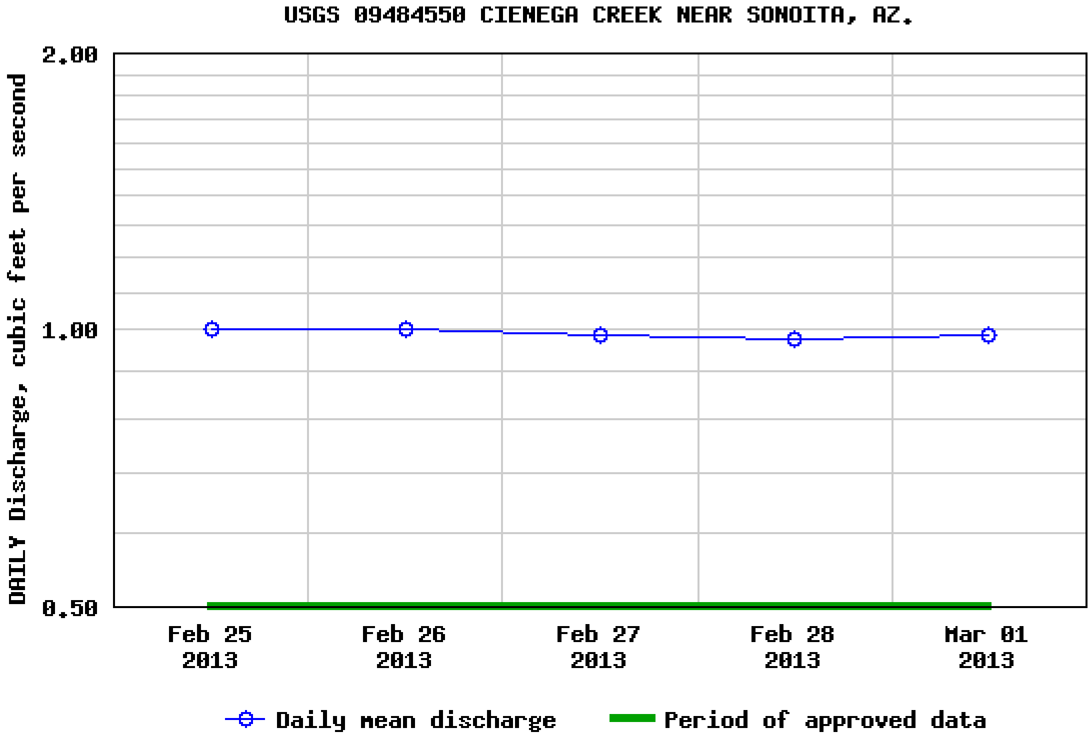

USGS 09484550 CIENEGA CREEK NEAR SONOITA, AZ.
DAILY Discharge, cubic feet per second
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
Aug 28 2012
Aug 29 2012
Aug 30 2012
Aug 31 2012
Sep 01 2012
Daily mean discharge
Period of approved data

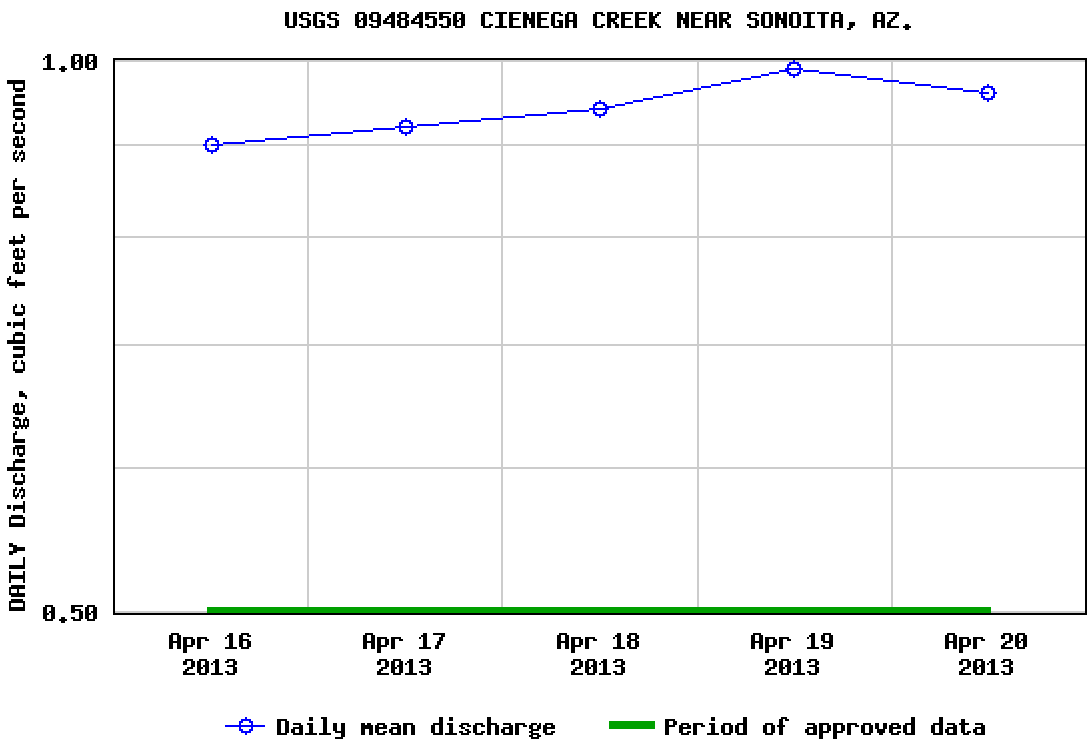


USGS 09484550 CIENEGA CREEK NEAR SONOITA, AZ.
DAILY Discharge, cubic feet per second
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
Sep 08 2012
Sep 09 2012
Sep 10 2012
Sep 11 2012
Sep 12 2012
Daily mean discharge
Period of approved data

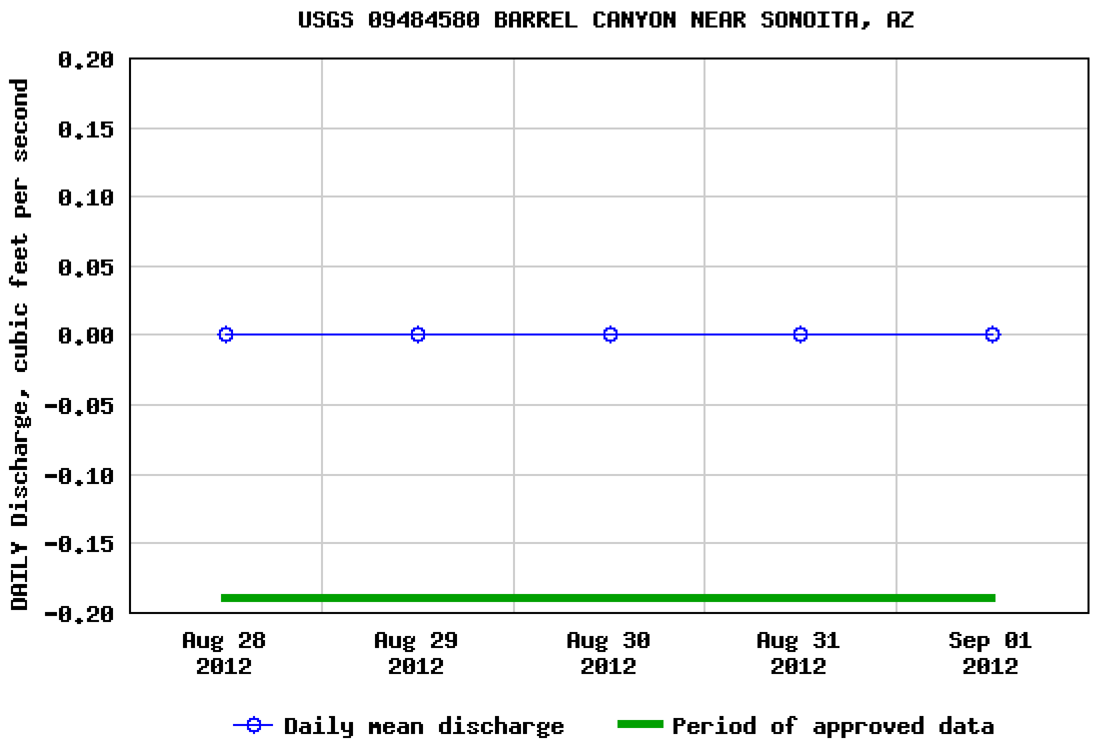


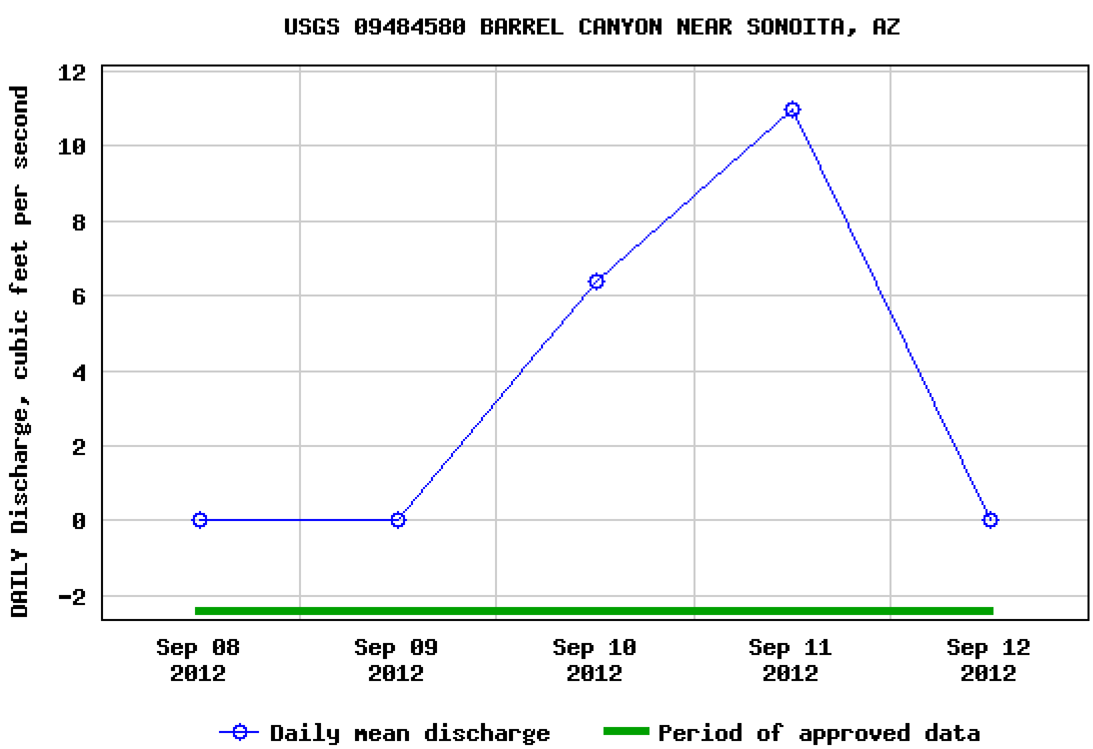
USGS 09484550 CIENEGA CREEK NEAR SONOITA, AZ.
DAILY Discharge, cubic feet per second
1.00
0.50
Nov 18 2012
Nov 19 2012
Nov 20 2012
Nov 21 2012
Nov 22 2012
Daily mean discharge
Period of approved data

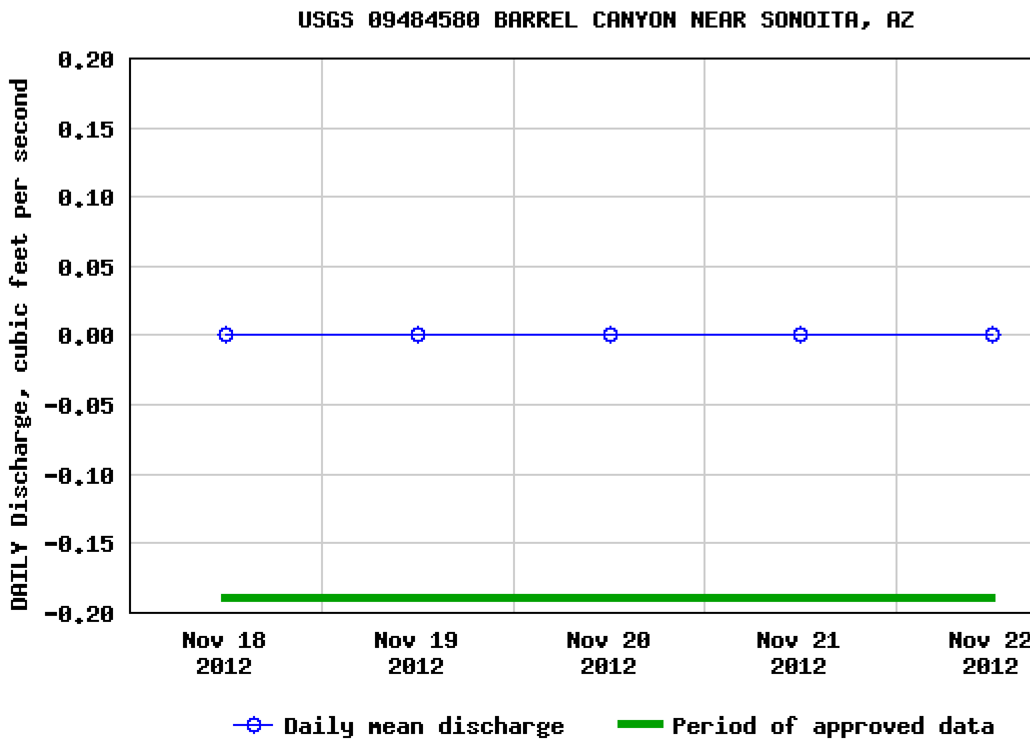

USGS 09484550 CIENEGA CREEK NEAR SONOITA, AZ.
DAILY Discharge, cubic feet per second
2.00
1.00
0.50
Feb 25 2013
Feb 26 2013
Feb 27 2013
Feb 28 2013
Mar 01 2013
Daily mean discharge
Period of approved data

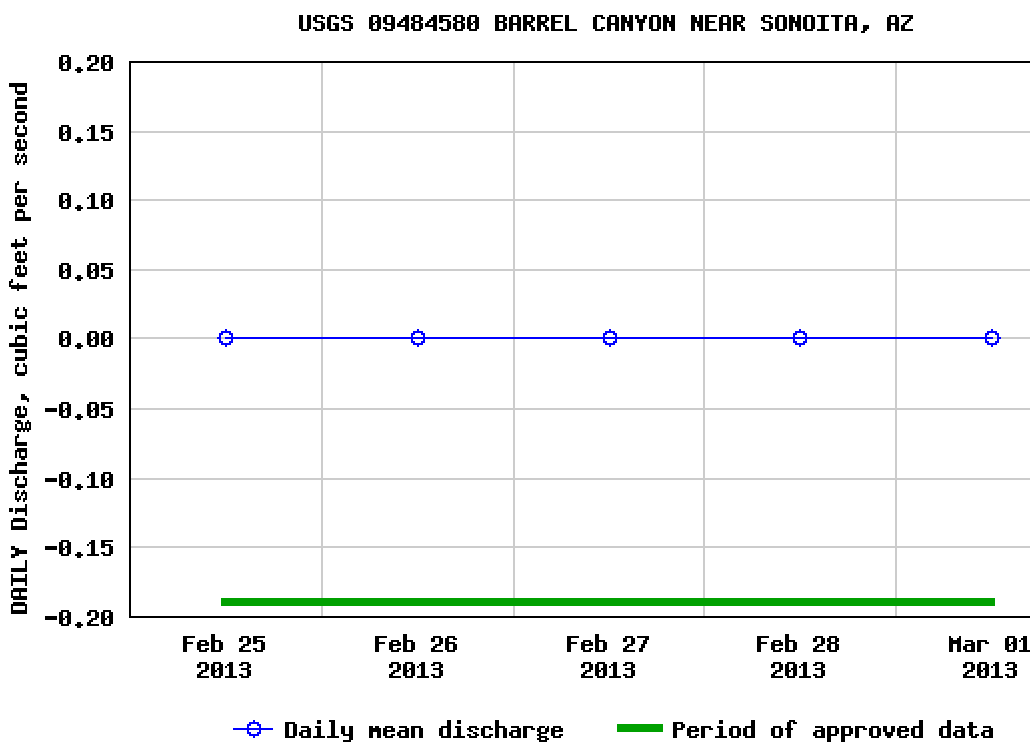

USGS 09484550 CIENEGA CREEK NEAR SONOITA, AZ.
DAILY Discharge, cubic feet per second
1.00
0.50
Apr 16 2013
Apr 17 2013
Apr 18 2013
Apr 19 2013
Apr 20 2013
Daily mean discharge
Period of approved data

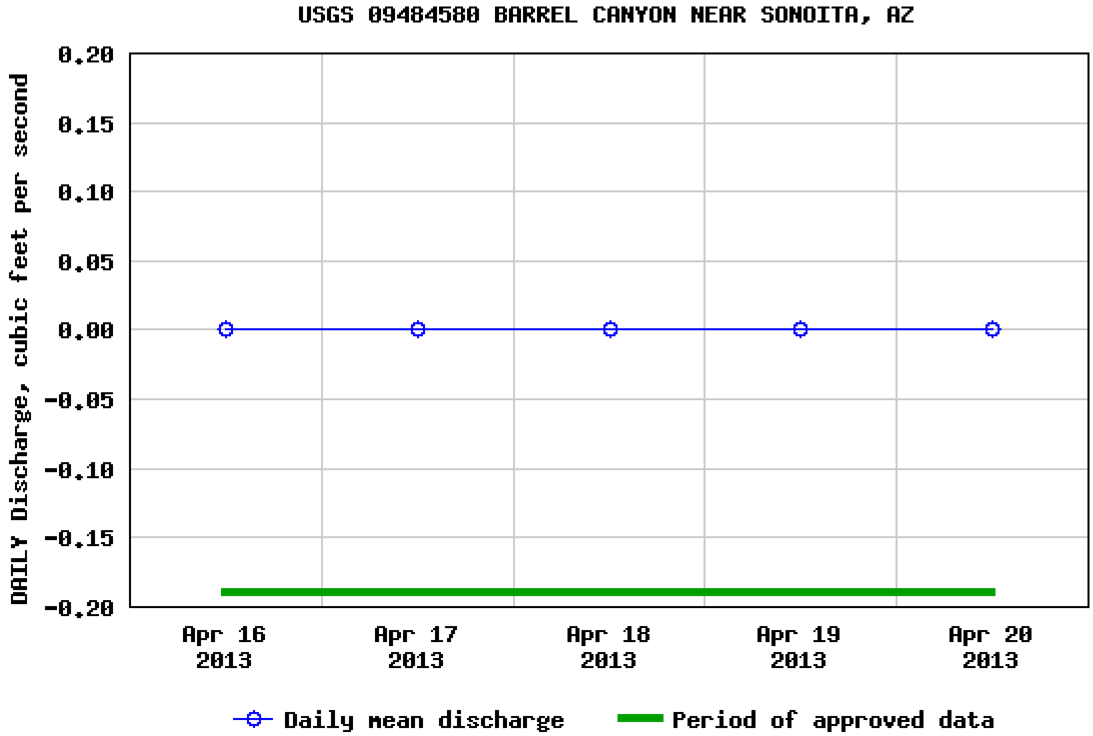
HYDROGRAPHS FROM USGS GAGE 09484580






USGS 09484580 BARREL CANYON NEAR SONOITA, AZ
DAILY Discharge, cubic feet per second
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
Nov 18 2012
Nov 19 2012
Nov 20 2012
Nov 21 2012
Nov 22 2012
Daily mean discharge
Period of approved data


USGS 09484580 BARREL CANYON NEAR SONOITA, AZ
DAILY Discharge, cubic feet per second
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
Feb 25 2013
Feb 26 2013
Feb 27 2013
Feb 28 2013
Mar 01 2013
Daily mean discharge
Period of approved data


USGS 09484580 BARREL CANYON NEAR SONOITA, AZ
DAILY Discharge, cubic feet per second
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
Apr 16
2013
Apr 17
2013
Apr 18
2013
Apr 19
2013
Apr 20
2013
Daily mean discharge
Period of approved data

Review of Possible Flow Evidence for All Cienega Creek and Davidson Canyon Water Quality Sampling Dates					
Date	USGS Gage 09484550 on Cienega Creek	USGS Gage 09484580 on Barrel Canyon	Pima County ALERT Precip Data	Rosemont On-Site Precip Data	Field Flow Measurement (cfs)
29-May-87	n/a	n/a	n/a	n/a	1
21-Aug-87	n/a	n/a	n/a	n/a	n/a
15-Oct-87	n/a	n/a	n/a	n/a	2
24-Nov-87	n/a	n/a	n/a	n/a	1.92
18-Jan-88	n/a	n/a	n/a	n/a	3
05-Apr-88	n/a	n/a	n/a	n/a	1.62
04-May-88	n/a	n/a	n/a	n/a	n/a
20-Jul-88	n/a	n/a	n/a	n/a	10.7*
21-Sep-88	n/a	n/a	n/a	n/a	1.74
22-Nov-88	n/a	n/a	n/a	n/a	2.04
25-Jan-89	n/a	n/a	n/a	n/a	1.8
30-Mar-89	n/a	n/a	n/a	n/a	0.38; 2.04
23-May-89	n/a	n/a	n/a	n/a	0.28; 0.45; 1.11
25-Jul-89	n/a	n/a	n/a	n/a	0.22; 0.36; 0.72
24-Sep-89	n/a	n/a	n/a	n/a	0.09; 0.26; 0.67
21-Nov-89	n/a	n/a	n/a	n/a	0.15; 0.4; 1.07
31-Jan-90	n/a	n/a	n/a	n/a	0.34; 0.52; 1.98
27-Mar-90	n/a	n/a	n/a	n/a	0.51; 0.61; 1.7
30-May-90	n/a	n/a	n/a	n/a	1.03
10-Jul-90	n/a	n/a	n/a	n/a	1.38
01-Oct-90	n/a	n/a	n/a	n/a	1.79
13-Nov-90	n/a	n/a	n/a	n/a	1.32
14-Nov-90	n/a	n/a	n/a	n/a	1.78
14-Jan-91	n/a	n/a	n/a	n/a	2.25
06-Mar-91	n/a	n/a	n/a	n/a	2.41
28-May-91	n/a	n/a	n/a	n/a	1.57
16-Jul-91	n/a	n/a	n/a	n/a	0.98
25-Sep-91	n/a	n/a	n/a	n/a	0.6
20-Nov-91	n/a	n/a	n/a	n/a	0.95
26-Nov-91	n/a	n/a	n/a	n/a	1.61
30-Jan-92	n/a	n/a	n/a	n/a	1.82
31-Jan-92	n/a	n/a	n/a	n/a	2.34

Review of Possible Flow Evidence for All Cienega Creek and Davidson Canyon Water Quality Sampling Dates					
Date	USGS Gage 09484550 on Cienega Creek	USGS Gage 09484580 on Barrel Canyon	Pima County ALERT Precip Data	Rosemont On-Site Precip Data	Field Flow Measurement (cfs)
19-Mar-92	n/a	n/a	n/a	n/a	1.72
17-Apr-92	n/a	n/a	n/a	n/a	n/a
14-May-92	n/a	n/a	n/a	n/a	1.23
27-May-92	n/a	n/a	n/a	n/a	0.2
20-Jul-92	n/a	n/a	n/a	n/a	0.69
06-Aug-92	n/a	n/a	n/a	n/a	1.35
18-Sep-92	n/a	n/a	n/a	n/a	0.55
06-Nov-92	n/a	n/a	n/a	n/a	0.02; 0.41
14-Nov-92	n/a	n/a	n/a	n/a	0.95
16-Feb-93	n/a	n/a	n/a	n/a	2.55
16-Mar-93	n/a	n/a	n/a	n/a	2.61
16-Apr-93	n/a	n/a	n/a	n/a	n/a
21-Apr-93	n/a	n/a	n/a	n/a	0.26; 1.45
27-May-93	n/a	n/a	n/a	n/a	1.2
18-Aug-93	n/a	n/a	n/a	n/a	0.88
25-Aug-93	n/a	n/a	n/a	n/a	0.89
22-Nov-93	n/a	n/a	n/a	n/a	2.03
29-Nov-93	n/a	n/a	n/a	n/a	1.23
25-Jan-94	n/a	n/a	n/a	n/a	1.76
10-Mar-94	n/a	n/a	n/a	n/a	2.18
21-Apr-94	n/a	n/a	n/a	n/a	2.3
25-May-94	n/a	n/a	n/a	n/a	1.56
01-Aug-94	n/a	n/a	n/a	n/a	0.42
27-Sep-94	n/a	n/a	n/a	n/a	0.63
30-Nov-94	n/a	n/a	n/a	n/a	1.1
17-Mar-95	n/a	n/a	n/a	n/a	2.55
17-May-95	n/a	n/a	n/a	n/a	0.43
20-Jul-95	n/a	n/a	n/a	n/a	0.08
27-Sep-95	n/a	n/a	n/a	n/a	0.32
31-May-96	n/a	n/a	n/a	n/a	0.1
28-Sep-98	n/a	n/a	n/a	n/a	0.26; 0.35
29-Sep-98	n/a	n/a	n/a	n/a	0.07; 0.1
30-Sep-98	n/a	n/a	n/a	n/a	0.29; 0.92
11-Dec-00	n/a	n/a	n/a	n/a	0.63; 1.28; 2.24
12-Dec-00	n/a	n/a	n/a	n/a	2.43
16-Feb-01	n/a	n/a	n/a	n/a	0.71; 1.81

Review of Possible Flow Evidence for All Cienega Creek and Davidson Canyon Water Quality Sampling Dates					
Date	USGS Gage 09484550 on Cienega Creek	USGS Gage 09484580 on Barrel Canyon	Pima County ALERT Precip Data	Rosemont On-Site Precip Data	Field Flow Measurement (cfs)
22-Feb-01	n/a	n/a	n/a	n/a	1.26; 1.95
24-Mar-01	n/a	n/a	n/a	n/a	n/a
17-Apr-01	n/a	n/a	n/a	n/a	0.75; 1.2
18-Apr-01	n/a	n/a	n/a	n/a	1.64
19-Apr-01	n/a	n/a	n/a	n/a	0.56
20-Apr-01	n/a	n/a	n/a	n/a	n/a
19-Jul-01	n/a	n/a	n/a	n/a	n/a
18-Sep-01	No change in flow observed	n/a	n/a	n/a	0.24; 0.55; 0.69; 0.8
17-Dec-01	No change in flow observed	n/a	0 inches recorded	n/a	1.05; 1.12; 1.38; 1.76
20-Mar-02	No change in flow observed	n/a	0 inches recorded	n/a	0.39; 1.35; 1.75; 1.8
04-Jun-02	No change in flow observed	n/a	0 inches recorded	n/a	n/a
02-Aug-02	Change in flow on 8/3/02, but none on 8/2/02	n/a	0 inches recorded	n/a	n/a
03-Oct-02	Slight change in flow observed, but not strong response	n/a	0 inches recorded	n/a	n/a
03-Jan-03	No change in flow observed	n/a	0 inches recorded	n/a	n/a
08-May-03	Decreasing flow observed	n/a	0 inches recorded	n/a	n/a
26-Sep-05	No change in flow observed	n/a	0 inches recorded	n/a	0.65
27-Sep-05	No change in flow observed	n/a	0 inches recorded	n/a	0.5
06-Dec-05	Rising flow, but not strong response	n/a	0 inches recorded	n/a	0.72
07-Dec-05	No change in flow observed	n/a	0 inches recorded	n/a	1.1
14-Feb-06	No change in flow observed	n/a	0 inches recorded	n/a	0.74
16-Feb-06	No change in flow observed	n/a	0 inches recorded	n/a	1.1
10-Apr-06	Decreasing flow observed	n/a	0 inches recorded	n/a	0.61

Review of Possible Flow Evidence for All Cienega Creek and Davidson Canyon Water Quality Sampling Dates					
Date	**USGS Gage 09484550 on Cienega Creek**	**USGS Gage 09484580 on Barrel Canyon**	**Pima County ALERT Precip Data**	**Rosemont On-Site Precip Data**	**Field Flow Measurement (cfs)**
12-Apr-06	Decreasing flow observed	n/a	0 inches recorded	n/a	0.72
24-Jun-08	Change in flow on 6/26/08, but none on 6/24/08	n/a	0 inches recorded	n/a	n/a
19-Aug-08	Decreasing flow observed	n/a	0 inches recorded	n/a	n/a
21-Oct-08	No change in flow observed	n/a	0 inches recorded	n/a	n/a
22-Oct-08	Rising flow, but not strong response	n/a	0 inches recorded	n/a	n/a
30-Aug-12	No change in flow observed	No change in flow observed	0 inches recorded	n/a	0.16; 0.18
10-Sep-12	No change in flow observed	Start of three day flow event*	Precipitation recorded in all gages*	n/a	0.003; 0.01; 0.28; 0.7
20-Nov-12	No change in flow observed	No change in flow observed	0 inches recorded	n/a	0.004; 0.01; 0.18; 0.5
27-Feb-13	No change in flow observed	No change in flow observed	0 inches recorded	n/a	0.28; 0.54
18-Apr-13	No change in flow observed	No change in flow observed	0 inches recorded	n/a	0.2; 0.32

* Flow is high enough to indicate that sample may be stormflow, not baseflow

n/a – Not Available